Popular Science

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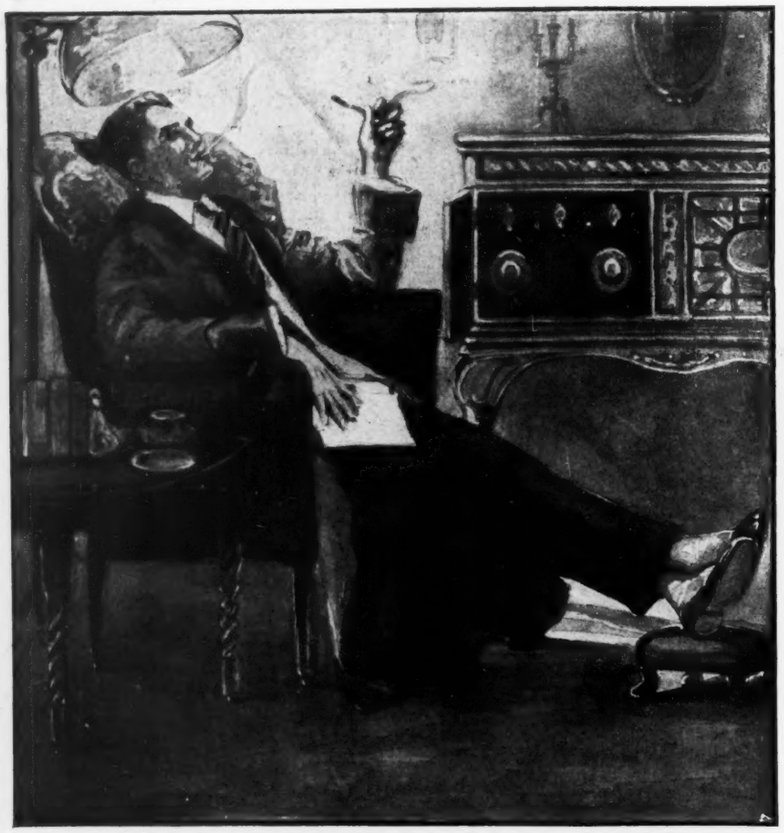
FEBRUARY *Announcing the Year's Most Fascinating Serial* (Page 31) 25 CENTS



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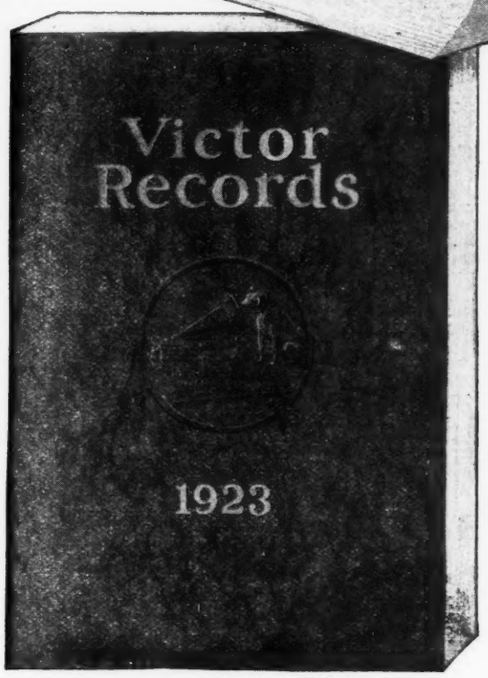

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POPULAR SCIENCE MONTHLY

FEBRUARY, 1923; Vol. 102, No. 2
25 cents a Copy; $2.50 a Year

Published in New York City at
225 West Thirty-ninth Street

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Meet the Author of the Year's Most Fascinating Serial

MANY good friends of POPULAR SCIENCE MONTHLY have told us that the story of "How 'Borax' Smith Came Back"—that astonishing romance of science and industry published in our issue of December last—was the best article we ever printed.

There are just two reasons why that story was unique.

The first is because it was a romance of *real life*.

The other is because it was signed by Dr. E. E. Free—America's foremost writer of popular science. Doctor Free knows *how* to write. Read his article on "What Is Inside the Earth," in this issue, and see whether you don't feel like voting him a gold medal for making the usually confusing realms of pure science vivid to the layman.

Dr. E. E. Free

Author of "The Story of Man and His World," the fascinating new serial that will begin next month in POPULAR SCIENCE MONTHLY

AS ONE of the scant half dozen men of scientific eminence in this country who have the knack of telling the dramatic secrets of science in wholly popular style, E. E. Free was ideally fitted to write the remarkable scientific feature which we are announcing this month.

"The Story of Man and His World," by Doctor Free, has been called "the most fascinating serial ever published by a magazine" simply because it has the same qualities, on a grander scale, that made the "Borax" Smith romance delightful.

It is every word of it stranger than fiction just because it is *fact*—because it is a story based on the most magnificent of all plots, Nature's great plan of Evolution, more thrilling than any fiction story ever conceived by man. *And the other reason it is wonderful reading is that E. E. Free wrote it.*

MEMBER of a dozen scientific and technical societies, with a degree of Bachelor of Arts in chemistry at Cornell and a doctorate in biology at Johns Hopkins, Doctor Free has been chemical engineer, assistant chemist at the University of Arizona, physicist of the United States Bureau of Soils, scientist for the Department of Agriculture undertaking potash deposit investigations in the Western deserts, and special assistant in the laboratory of plant physiology at Johns Hopkins University.

During the war he served as captain in the Ordnance Department and then as major in the Chemical Warfare Service.

His career has made him an expert in an amazing variety of subjects ranging from geology, chemistry, and engineering, to biology and even scientific detective work!

BUT, most important of all, Doctor Free took to literature. Even while engaged in practical scientific work, he continued to practice that other rare science of writing simple English. He has perfected an unusual ability to introduce the public, in plain, readable but vivid language, to some of that vast store of scientific knowledge that hitherto only scientists like himself have been able to enjoy. Scores of his articles have appeared in popular magazines, in engineering, chemical, and mining journals, and in technical publications of some of the nation's foremost research institutions.

Thus do Doctor Free's versatile scientific knowledge, dynamic personality, and remarkably readable literary style combine to make unique his great panorama of the wonders of science—"The Story of Man and His World," which starts in our next month's issue.

Turn to page 31 and read the announcement of this great new serial story, which will continue throughout the year.

POPULAR SCIENCE MONTHLY

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H. J. Fisher, *President*; R. C. Wilson, *Vice-President*
O. B. Capen, *Secretary and Treasurer*

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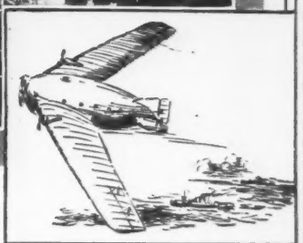
Men of the Hour in Science

Intimate Glimpses of Foremost Leaders in Research and Discovery

Dr. Alexis Carrel

AS SURGEON of the Rockefeller Institute, New York, Doctor Carrel has entered hitherto unexplored realms of scientific research to learn secrets of why we live, why we become sick, and why we die. In experiments with living body cells—in the course of which he has kept an isolated piece of chicken heart alive and growing for six years!—he has discovered startling new facts about white corpuscles. These corpuscles, he has just announced, not only destroy microbes, but stimulate healthful new growth in body tissues attacked by them.



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Lieut. Charles Nungesser

NOT content with fame and fortune, this retired "ace" of the French Army, who brought down 105 enemy planes during the war, is devoting his practical knowledge to further conquest of the air.

He recently announced the invention of an entirely new type of seaplane—egg-shaped body with queer wings—in which he hopes to fly from Paris to New York in 24 hours, and later to establish regular transatlantic passenger transportation. He plans also to build "jitney" seaplanes to sell for $1000 each.

Ernest De K. Leffingwell

IN THE central picture is Ernest Leffingwell, of California—athlete, explorer, scientist, horticulturist, and owner of the highest honor medal within the gift of the British Royal Geographical Society. He is not only responsible for starting Vilhjalmur Stefansson on his historic Arctic explorations—with results described in the last POPULAR SCIENCE MONTHLY—but through his own explorations has given us the first accurate map of the whole north shore of Alaska. In addition, Leffingwell's adventurous explorations have cleared up many scientific problems relating to the Far North.

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Dr. Vernon Kellogg

IN HIS capacity as permanent secretary of the National Research Council, Doctor Kellogg (at left), like POPULAR SCIENCE MONTHLY, is endeavoring to unite the forces of science, industry, and education for the solution of public welfare problems, by interesting industry in the results of scientific research, and by developing a new generation of scientifically trained young men.

For this undertaking he is fitted by years of successful effort as a professor at Leland Stanford and as chief investigator for Hoover in war relief work.

"He is rich," said Confucius, "who knows when he has enough!"
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POPULAR SCIENCE MONTHLY
FEBRUARY, 1923

From $5-a-Week Beginner to Scientific Chief of the World's Greatest Telephone System

How J. J. Carty, Directing Marvelous Research Work by Army of 3000 Scientists, Has Developed Our Phone Service "Half a Century Ahead of Its Time"

By Harry A. Mount

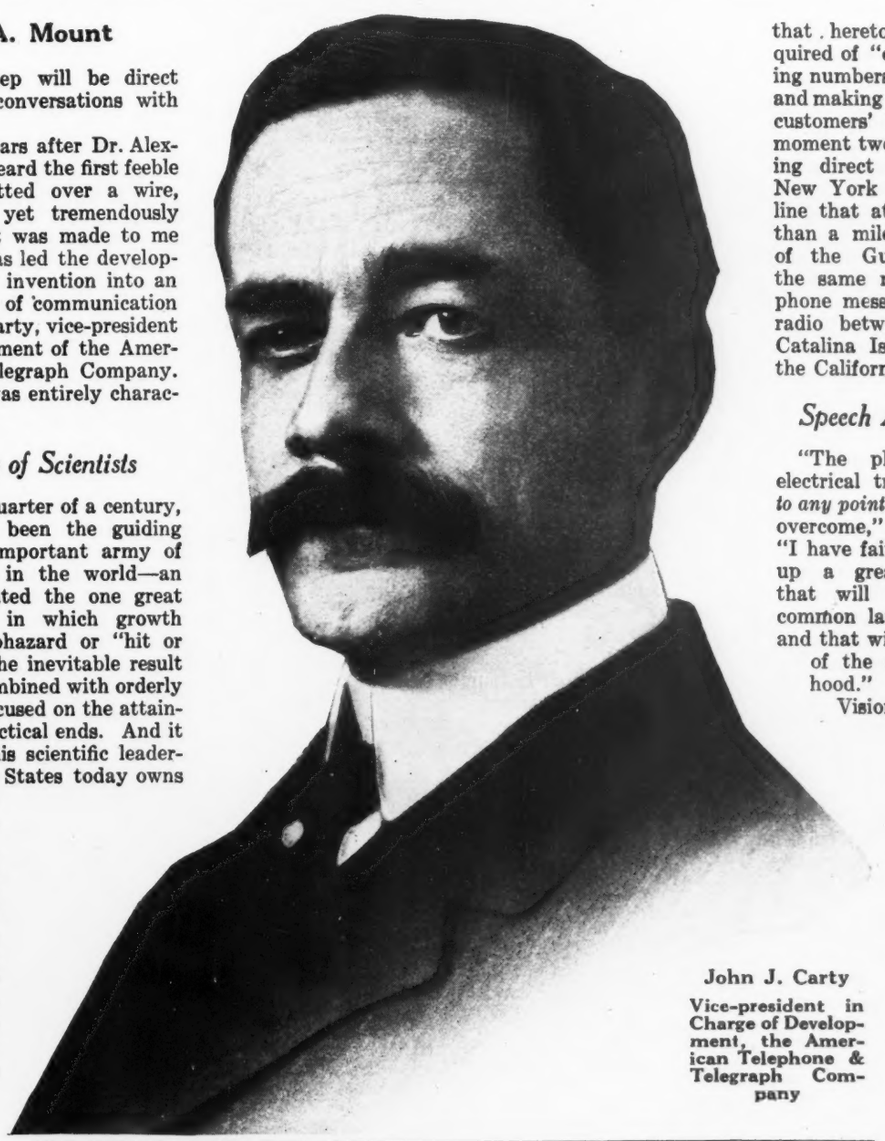
"THE next step will be direct telephone conversations with Europe."

Just 47 years after Dr. Alexander Graham Bell heard the first feeble sound ever transmitted over a wire, this matter-of-fact, yet tremendously significant statement was made to me by the genius who has led the development of Bell's baby invention into an indispensable system of communication—by Gen. John J. Carty, vice-president in charge of development of the American Telephone & Telegraph Company. And the statement was entirely characteristic of the man.

A Great Army of Scientists

For more than a quarter of a century, General Carty has been the guiding chief of the most important army of industrial scientists in the world—an army that has created the one great American industry in which growth never has been haphazard or "hit or miss," but always the inevitable result of keen foresight, combined with orderly scientific research focused on the attainment of definite, practical ends. And it is largely through his scientific leadership that the United States today owns and operates one third of all the world's telephones.

My conversation with Carty took place in an office on the twenty-sixth floor of a great building in New York which is the very nerve center of the vast network of telephone lines stretching from sea to sea—and beyond. While we talked, gangs were at work in a dozen large cities of the United States making the first installations of a marvelous new system of automatic switching that performs, without the touch of a human hand, all of the intricate functions that heretofore have been required of "central," even to ringing numbers on distant exchanges and making proper charges against customers' bills. At that same moment two operators were making direct connections between New York and Havana, over a line that at one point lies more than a mile beneath the waters of the Gulf Stream. And at the same moment, routine telephone messages were passing by radio between an exchange on Catalina Island and another on the California mainland.



John J. Carty
Vice-president in Charge of Development, the American Telephone & Telegraph Company

Speech Around the World

"The physical obstacles to electrical transmission of speech *to any point in the world* have been overcome," I heard Carty saying. "I have faith that we shall build up a great telephone system that will bring into being a common language for all nations, and that will join all the peoples of the earth in one brotherhood."

Visionary? Wait until you know Carty, the practical doer of "impossible" deeds. Here is a man who, as a youth of slight build and somewhat retiring disposition, went to work at five dollars a week on a telephone system consisting of a few iron wires strung about the city of Boston, and a few crude instruments, used both as transmitters and receivers, which sometimes would work if one shouted into them.

At the end of three years, in 1880, young Carty had quietly introduced the first great advance toward the modern telephone—the full metallic circuit—and was fairly launched on his remarkable career as

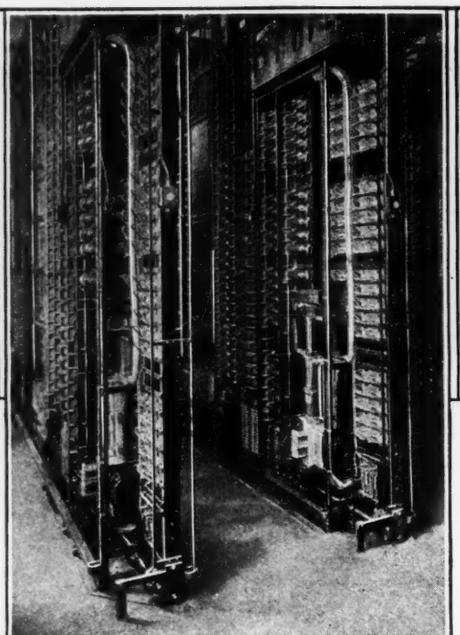
What Organized Research Has Given You in Service

FORTY-FIVE years ago, John J. Carty, then a retiring youth of 16, was working for five dollars a week on a telephone system that consisted of a few iron wires strung about the city of Boston. Today he leads the technical development of the one great industry that has progressed, not because of occasional inventive brilliancy or haphazard driving power, but because of the application of orderly, scientific methods.

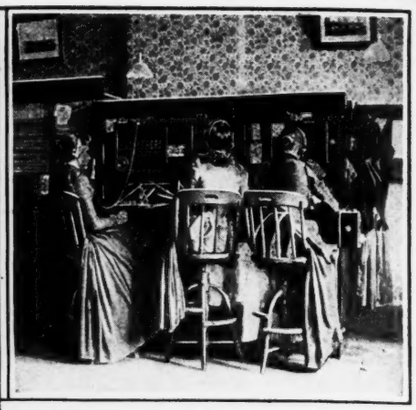
Telephone communication in America is what it is today—at least half a century in advance of other nations—because General Carty and his staff of 3000 engineers learned how to foresee the problems of their industry, and to have the solution of these problems completed when the time came to meet them.

This is the true way of exact science—the way of untiring research, and of final fulfilment in valuable service.

The first telephone exchange, 1885—from a contemporary drawing. Here an operator, seated at a "central desk, shouted incoming calls to boy assistants who dashed about the room pushing brass pegs into holes and so making connections



A marvel of modern telephony—the automatic switchboard that enables telephone users to make their own connections accurately without the aid of a human "central." This intricate, silent sentinel—born out of the hubbub and clatter of oldtime exchanges—is the outcome of the Bell laboratories, direction of scientific research work



This is an actual photograph of one of the first crude multiple switchboards, showing "central" operators at work. These instruments, the forerunners of our modern switchboards, connected only a few hundred telephone subscribers

an industrial general before whom a host of "scientifically impossible" obstacles in the way of the modern telephone has retreated.

Not once, but again and again, Carty and his co-workers in telephone development faced apparently insurmountable situations that threatened not only to halt further advance of the telephone, but even to destroy the existing system. Indeed, an entirely new industry had to be built from the ground up; for at the time Carty became one of the guiding geniuses of the telephone, the wisest men knew less about delicate electrical voice currents than does the average high school boy of today. Even Alexander Graham Bell, who planted the seed of the great enterprise that bears his name, could do little more than supply the great inventive idea—an idea so crudely worked out at first that while a person could telephone across the street, the instrument and system were entirely ineffective at greater distances.

Every Step Carefully Planned

Each advance since that day has been deliberately planned, worked out in a laboratory, and finally executed with the cooperation of many minds. There has been no single creator of the telephone. But guiding and directing the whole course of telephone evolution has been the genius of Carty, first as manager of equipment and traffic for the original Telephone Despatch Company; later as chief engineer for the New York Telephone Company; finally as chief engineer and now vice-president of the American Telephone & Telegraph Company.

Today he is head of a force of more than 3000 scientists, engineers, and assistants whose job it is to improve and extend telephone service. Under his guidance science applied to industry has had its most grandiose test; and as a result of this tireless effort to solve vast problems by scientific research years before they actually became acute, it is safe to say that the system now in service in the United States is fully half a century ahead of its time as measured by "normal" progress in Europe.

When Carty entered the business, iron wire was used and each individual wire carried one telephone connection, the ground being used to complete the circuit.

"All manner of squeaks, squawks, and howls came over the wire," said Carty, recalling the difficulties of these early circuits; "but if you shouted at the top of your voice, sometimes you could manage to be heard at the other end. When two wires were strung side by side, the effect of induction was such that if a person talked at either end of one of the lines, you could hear his voice at the distant end of either line."

But the faith of Carty and his colleagues in the telephone reached beyond the limitations of their instruments. One of Carty's first big jobs was to string up a "long distance" line between Boston and Lawrence, Mass., a distance of about 26 miles. This was to supply a newspaper office with telephone service—a feat that required the services of a telegraph operator stationed at the end of the line to take the messages in code whenever the telephone should refuse to work!

In the construction of the line, two wires were put up to provide two circuits and it was in the study of these two circuits that Carty conceived an idea that was destined to become tremendously important in telephone communication. He determined to use one of the wires in place of the ground, as a return circuit. He gave a workman instructions as to how to hitch up the instruments at Lawrence and he himself made the connections at Boston. Then he spoke over the line to the girl operator at Lawrence—and a miracle occurred. The line was perfectly quiet!

The Full Metallic Circuit

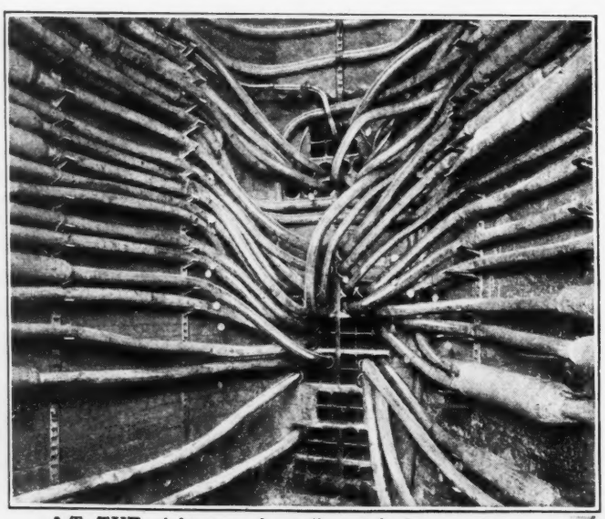
"What did you do?" cried the astonished operator, when she heard Carty's voice.

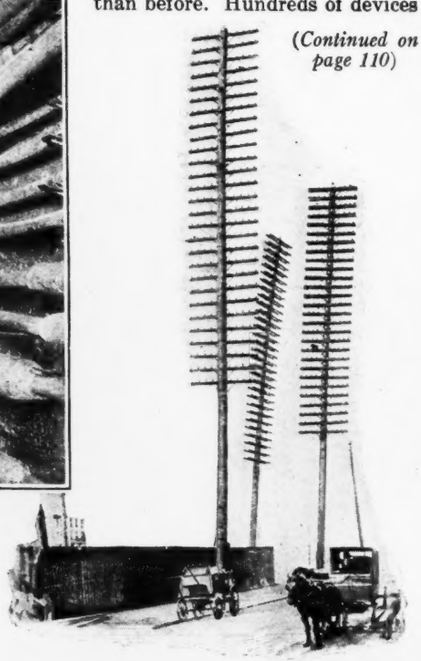
"Why," replied Carty, "I am using a full metallic circuit."

"Gee," said the girl enviously, "I wish we had one of those things down here!"

Then came a new problem. It was found that when two full metallic circuit lines were built side by side, induction or "cross talk" occurred much more readily than before. Hundreds of devices

(*Continued on page 110*)





AT THE right are the tallest telephone poles ever erected, as they appeared in New York twenty years ago. Such monstrosities, built to meet increasing business, resulted in public demand that the lines be put under ground—as shown above. The cables in this conduit are the busiest in the world. While the poles carried about 280 wires, the cables shown contain 22,624 wires

Airtight Tank to Prevent Huge Oil Loss

New Fireproof Floating Roof Designed to Reduce $100,000,000 Annual Fuel Waste, Caused by Flames and Evaporation

WOULD you believe that you could envelop a tank full of fuel oil with a roaring fire without inviting certain disaster?

By doing that very thing during tests of a newly devised floating safety roof, experimenters of the Underwriters' Laboratory recently demonstrated not only that oil tanks can be safeguarded from fire, but that the millions of dollars' worth of oil and its by-products lost each year through fire, lightning, and evaporation, can be saved.

Piling inflammable material on the top and around the sides of a model tank equipped with the safety roof, the experimenters poured oil on the tinder, set fire to it, then watched to see what would happen. And while the flames leaped high, this is what did happen:

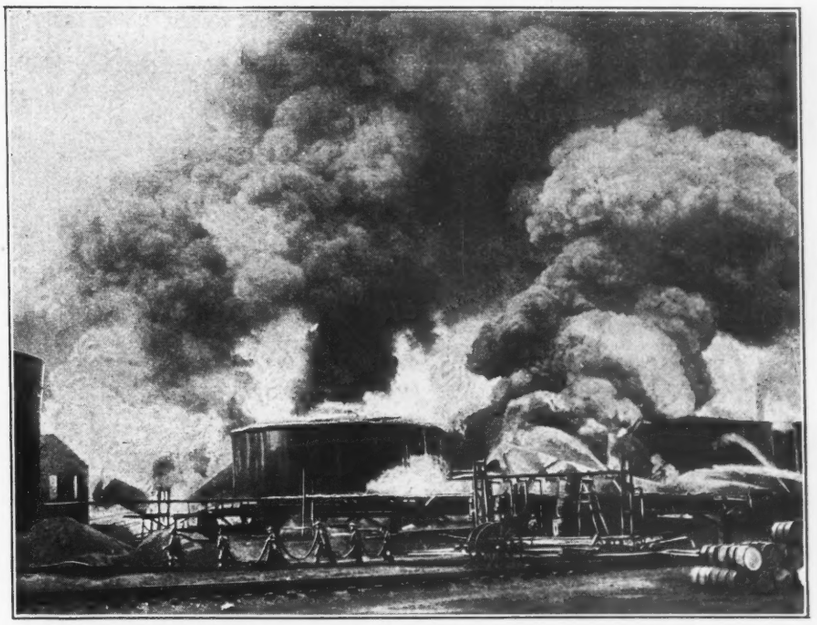
Oil Boils without Igniting

The oil in the tank actually boiled from the terrific heat, yet it neither exploded nor ignited. After the fire had died down, the tank and its contents remained unscathed!

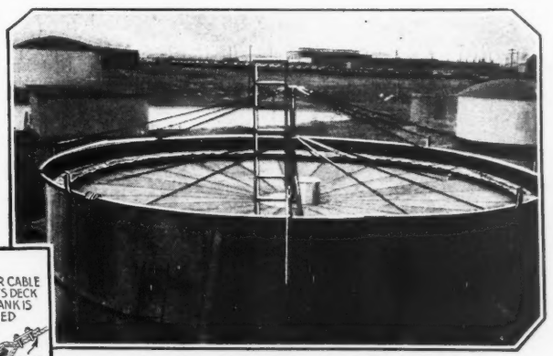
The safety roof that protected the oil throughout this amazing test is said to be the crowning achievement of inventors who have been endeavoring to relieve the increasing shortage in our available gasoline and oil supply—a shortage due in a large measure to evaporation and destruction by fire.

The total loss of oil by evaporation each year is estimated at 600,000,000 gallons, valued at about $150,000,000. On the way from the wells to the refineries 300,000,000 gallons of gasoline, evaporating from the crude petroleum, is wasted annually in the air, representing a preventable loss of $75,000,000. In addition, $7,500,000 worth of oil is destroyed annually by fire and lightning in devastating conflagrations that destroy $6,500,000 worth of other property and often result in loss of life.

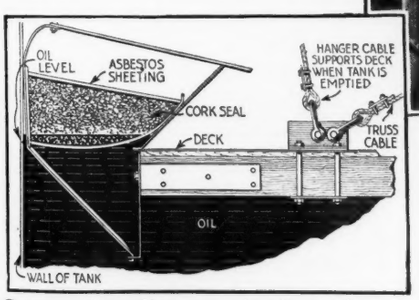
The critical need of lessening such tremendous losses, led to the invention of the new safety roof, which can be adjusted to fit any oil tank. It is said to be fireproof, lightning proof, and evaporation proof, and consists of a floating cover, the circumference of which is built slightly smaller than that of the tank it is designed to fit. This floating roof rests on the surface of the oil so that no air may intervene between that surface and the roof.



A lightning bolt, striking one of the great tanks at the Tidewater oil plant, Bayonne, N. J., started this destructive conflagration—typical of the preventable fires that destroy $7,500,000 worth of oil and $6,500,000 in property in the United States each year. To reduce this loss the airtight tank has been designed



An oil tank made fireproof and evaporation proof by a newly invented roof that floats on the surface of the oil, thus excluding oxygen necessary for combustion



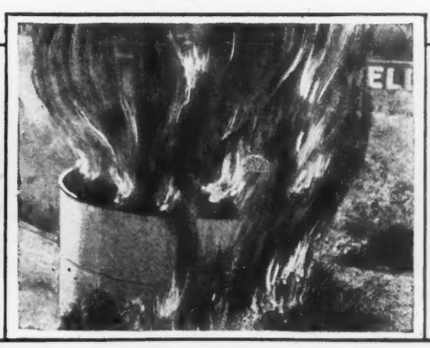
Cross-section diagram of safety oil tank showing construction of floating roof that precludes fire and evaporation. Note cork seal filling space between rim of the circular roof and the tank wall

How Roof Is Sealed

Surrounding the floating roof and lying against the wall of the tank is a gravel or cork "seal," which fills in the space between the rim of the roof and the tank, and automatically adjusts itself to irregularities.

This seal is provided with a deck that turns rainfall onto the main roof, which is equipped with pipes to drain off the water. Investigation has shown that oil fires resulting from lightning are due to the fact that lightning sets off highly combustible gases that accumulate in tanks.

Preparing the fire test. The tank, filled with fuel oil, is covered with inflammable material that is saturated with oil



Enveloped in flames. Heated to the boiling point by the test fire, fuel oil in the tank neither exploded nor did it ignite

Through the fire unscathed. Here is the tank as it appeared at the conclusion of the test, its contents untouched by the flames

Coué Brings His Magic Health Secrets to America!

By Edwin F. Bowers, M.D.
Author of "Teeth and Health," etc.

COUÉ is here!

He was scheduled to arrive in America the week this magazine appears on the newsstands.

Emile Coué is one of the most spectacular figures in the world today. He is popularly known as the greatest individual healer in history. At his modest home in Nancy, France, this modern miracle worker is reported to have cured 20,000 persons of a host of serious ailments. Crutches, observers tell us, are thrown away, cripples walk, paralyzed limbs are taught to move again.

A small town druggist of dynamic personality, who became a student of autosuggestion, Coué in the past 10 years has played host and healer to an army of sick and crippled peasants that came in pilgrimage to his doors.

Wins Fame by His Cures

More recently, called to England to demonstrate his powers, he gained fame by curing Lord Curzon of "a dangerous and stubborn malady," while scores of others in England claimed benefit from the novel treatment which now he is to demonstrate in this country.

But the most spectacular part of Coué's work is that he claims *for himself* no healing power at all—he merely teaches *you* to cure yourself, by the mysterious force of autosuggestion.

Everybody today knows this wonderworker's famous phrase, "Day by day, in every way, I am getting better and better." So common a catchword has it become that it is a model for endless newspaper jokes. But before you are led astray by ridicule, think of the effect of repeating an opposite phrase. Suppose you should say to yourself, in gloomy seriousness night and morning for months, "Day by day, in every way, I am getting sicker and sicker!" Common experience will prove to you that you would soon become depressed and ailing in fact, as a result of such a daily dose of unhealthful suggestion.

In that fact alone you have evidence of the powers of autosuggestion. Coué's results are accomplished by the operation of well known laws. Briefly, you have two distinct minds—the objective, or conscious, which receives all the impression from the outside world through your five senses; and the subjective, or unconscious, which controls the automatic functions of your body such as breathing, digestion, the beating of the heart, muscular and nervous reactions, and the processes of eliminating waste from the system.

The Power of the Unconscious

With the former we think, weigh alternatives, and deal with the material things in the world about us. The unconscious is the source of our dreams, the storehouse of our memory and of all the impressions that the world has made upon us—indeed, of a myriad impressions that we were not conscious of even as we received them. And this unconscious mind, guiding the functions of our organs, keeps us well, happy, and successful if we but give it the chance. But if we fill it with ideas of gloom and failure, it guides our actions not toward health and success, but toward disaster.

The secret of autosuggestion, then, as preached by Coué, is to implant in this unconscious mind the conviction of health and success. But how can this be done? We know by the new science of psychology that the unconscious is accessible only when the conscious mind drowses — when you are daydreaming, or half asleep. When your conscious mind is alert, it doesn't allow the unconscious a chance to realize its dreams.

Now Coué has invented a new method of feeding thoughts of health and success to the unconscious.

The rhythm of saying aloud over and over again, as you fall asleep, "Every day in every way I am getting better and better," serves to lull the conscious mind to inattention and by its repetition fixes the idea of universal improvement in health and ability in the unconscious. The string tied with twenty knots that you tell over as you repeat the phrase is merely a bit of ritual that permits you to be sure of plenty of repetition of the phrase without actually counting with your conscious mind, and so keeping the latter alert and defiant of the unconscious. The words are repeated aloud because thus the maximum of impression is made upon the unconscious by the muscular movements of mouth and throat and the nerve sensation of the ear, with the minimum of attention from the conscious mind.

Photo courtesy American Library Service

Emile Coué, known as the world's greatest faith healer, surrounded by just a few of one day's health-seeking pilgrims to his home. Reliable observers who have watched his work in Nancy, France, tell of amazing cures wrought by the methods of autosuggestion he teaches—of cripples who, after a short Coué treatment, throw away their crutches and run gaily up and down the garden

Many familiar experiences in life may be taken as instances to explain what Coué is driving at. In a game of baseball, one member of the team regularly plays magnificently. This is because the idea of success is deeply implanted in his unconscious mind, and the unconscious attends to all the instantaneous reactions of eye and nerve and muscle that make him hit and run and catch to perfection.

But another—a new player—is never quite sure of himself. He constantly though vaguely imagines himself failing to catch or hit the ball. Then, by a curious law of psychology, which Coué announces, the harder he wills to make a brilliant catch, the less chance he has of doing so. His imagination—dimly picturing failure—and his will—determined to succeed—are in desperate conflict, and in every such conflict the will loses.

Fear Grips Imagination

In many people, apparently, the imagination, feeding by its very nature upon the spectacular, is more ready to seize the dramatic or terrifying possibilities of failure than the calmer facts of success. Pictures of spectacular crashes, of disaster gathering like the storm, of falling from great heights, of making a glorious botch of what we are doing, seem to appeal to the imagination more than

(*Continued on page 113*)

Try This Experiment on Yourself

TO DEMONSTRATE the power of your unconscious thought to transform itself into action, tie an eight-inch string to the end of a pencil, and to the other end of the string attach a heavy metal button. Holding the pencil firmly in both hands, as shown, but without pressing your arms tensely to your side, suspend the button over the intersection of two diameters crossing at right angles in a circle, 10 inches across, previously drawn on a piece of paper.

Now let your eyes follow the line of one of the diameters. Soon the button will begin to swing along that line. Next, concentrate for a time on the other diameter; later, let your eyes follow the line of the circle. Each time, the movement of the button will change to follow the line you are thinking of, despite the efforts of your Will to hold the pencil motionless.

What Is Inside the Earth?

Amazing Scientific Discoveries Give New Explanation of Volcanic Flames—Earth's Center May Be Solid Mass of Precious Metals

By E. E. Free

ONE of the greatest of all scientific mysteries lies literally under your feet. It is the mystery of what is inside the earth.

Suppose you devised some kind of powerful digging machine, capable of withstanding terrific heat and pressure, and suppose you climbed inside it and started downward through the rock and kept on going, mile after mile, until you penetrated all the 3956 miles down to the center of the earth. What would you discover on the trip? What materials would you have to bore through?

No doubt you would expect to find a blazing central inferno of gases and molten metal. No doubt you have been led to believe this because it seems to explain the flames and seething lava that issue from volcanoes. The explanation of spouting geysers, hot springs, and earthquakes is also popularly traced to the supposed molten interior of the earth.

Until a few years ago scientists likewise would have expected to find a seething ocean of molten rock inside the earth—a central cauldron of lava still white hot from primeval fires. But today the scientist knows better. Today he knows that the earth is actually solid all the way through; that its interior is not molten rock at all, as most of us still believe, but a core of something more rigid than the strongest steel, probably a core of metal.

What Science Guesses

Just what that metal is, nobody knows for sure, but there are two especially interesting scientific guesses. Dr. William H. Hobbs, the distinguished professor of geology at the University of Michigan, guesses, for instance, that the earth has a center made up mostly of solid iron.

This sounds strange enough; but another theory—a more recent one—is much stranger still. "The heart of the earth," says this newer theory, "is a heart of gold!" At the very center of the globe there may be millions of tons of gold and silver and copper and platinum and the other heavy metals.

This is not mere fantastic speculation, but a sober deduction from the most critical investigation ever made in the chemistry of the earth's crust—an investigation conducted by the acknowledged world authority on this subject, Dr. Henry S. Washington, of the Carnegie Institution of Washington, D. C.

Doctor Washington, studying over 5000 trustworthy chemical analyses of the crust of the earth, found that the elements common in the crust are exclusively those of lighter weight. The heavier elements occur only in the most minute proportions. Gold, for instance, composes less than one millionth of one per cent of the earth's crust!

Yet Doctor Washington thinks it improbable that these heavier elements were always lacking. Then where is Mother Earth's missing quota of gold, platinum, and other heavy elements? Have they hidden themselves away out of our reach?

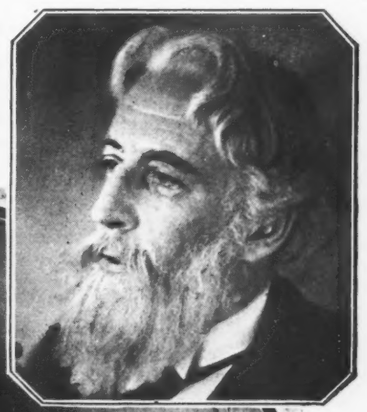
Doctor Washington believes that they have. He thinks that the earth was once molten. While it was in this condition the lighter elements rose to the surface; the heavier ones sank. He thinks that millions of tons of the missing elements are inside the earth now.

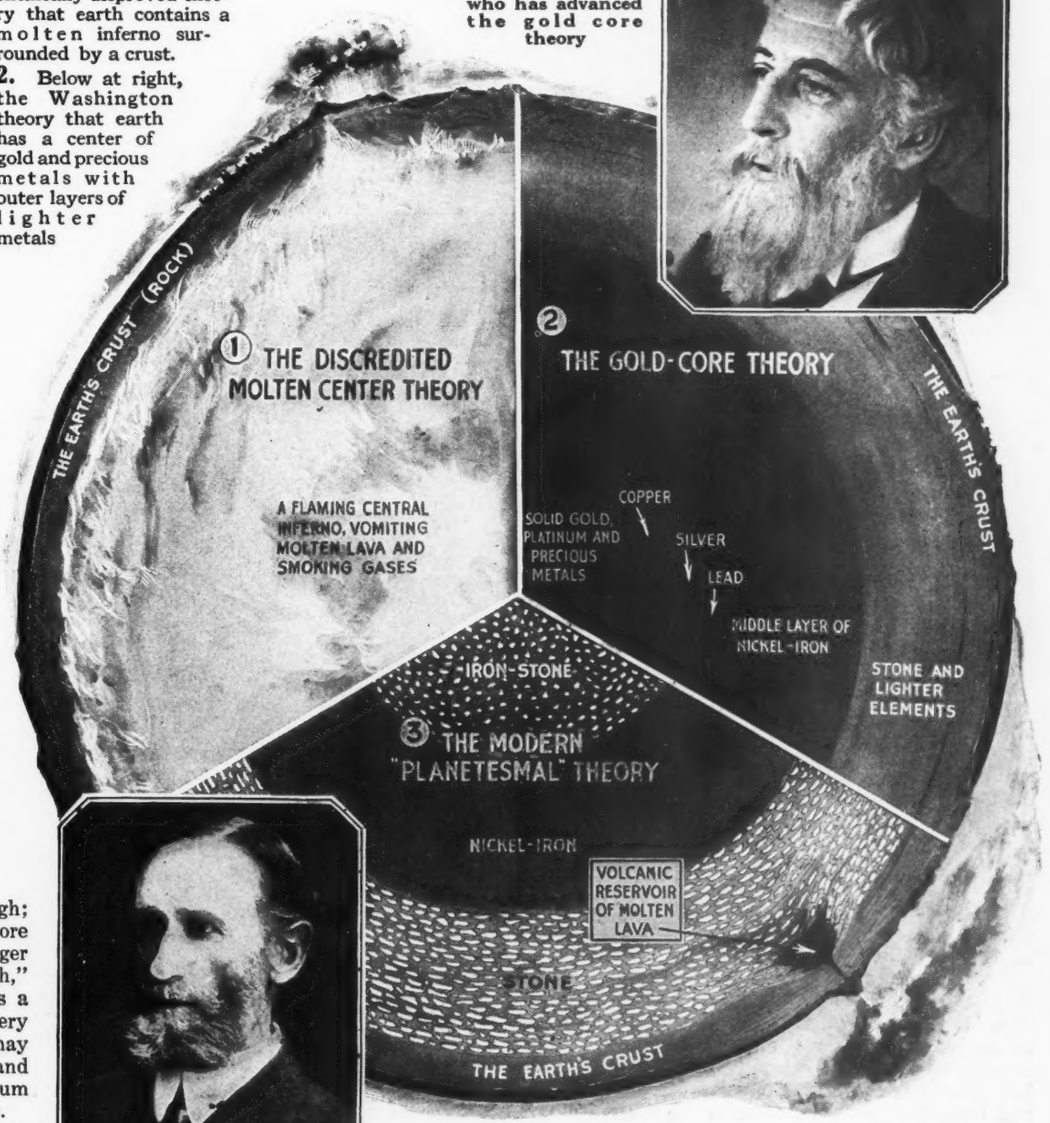
At the very center he would expect to find a core of the heaviest elements—such as platinum, gold, antimony, and osmium, the latter the heaviest known substance, familiar to us all in that natural alloy, "iridosmium," used for the tips of gold pens. Outside this sphere of precious metals there is, perhaps, a zone of those elements that are little less heavy—copper and silver and lead. If there is a zone of iron, as Doctor Washington

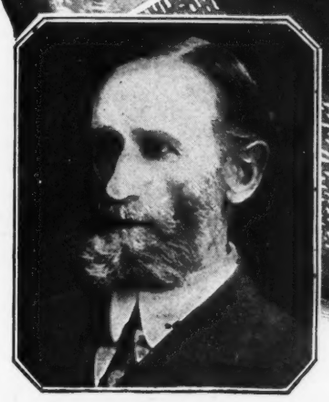
The Earth's Contents—The Old Idea and the New Ones

1. Below at left, the scientifically disproved theory that earth contains a molten inferno surrounded by a crust.
2. Below at right, the Washington theory that earth has a center of gold and precious metals with outer layers of lighter metals

At right: Dr. Henry S. Washington, who has advanced the gold core theory







3. Above, the theory that the earth was built up of accumulating lumps of metal and stone. At left, Dr. William H. Hobbs, geologist, leading exponent of this theory

thinks there is, it presumably comes next. Clear outside, on top of all the metallic zones, is the surface layer of the lightest elements—the slag layer, the rocky crust on which we live.

If this is true, where do the veins of gold, silver, and copper that we mine in the earth's crust come from? The generally accepted scientific answer is that they have been brought upward by seepages of hot mineralized water from the depths of the earth.

Old Ideas Upset

But whether or not the earth's center is solid gold, it is certainly something heavy. It contains something far more dense than any of the rocks we know on the surface. And if you are astonished by this fact, which upsets most popular beliefs, you may be still more astonished by the way scientists arrived at it. They know the earth must have something heavy inside it because, for one thing, it *weighs more than it should.*

I can hear you ask, "What! Has the whole world been weighed?" Yes — the world has been weighed. Scientists have in effect put Mother Earth on the scales and found that she tips the beam at nearly six thousand million million millions of tons.

Vesuvius in a recent eruption, showing flying masses of white-hot molten rock hurled from the exploding cone

But how, you ask, did the scientists do it? Well, they started nearly 150 years ago with a novel experiment. It was an Englishman named Maskelyne who first decided to try to weigh the earth. To begin with, he decided he would need a mountain that he could use as a known weight for comparison. So he hired an engineer and sent him all over the British Isles to find a suitable hill. This engineer, as it happens, was that same Charles Mason who afterward became famous as one of the men who ran the Mason and Dixon line separating America's "slave" and "free" states before the Civil War.

Weighing the Earth

After a long search, Mason selected a hill in Scotland. Two plumb bobs, or weights hung on strings, were then set up, one on each side of the hill. Such a plumb bob normally will point straight downward toward the center of the earth. That is, it will point downward when it is on a level plain so that the only force acting on it is the gravitational attraction of the earth.

But when the plumb bob is hung up near one side of a mountain, it will not point exactly downward. The mass of the mountain will attract the plumb bob just as the earth itself does, and since the mountain mass is alongside the plumb bob and not below it, it will attract the plumb bob sidewise. In scientific language, the plumb bob is "deflected from the exact vertical," and the amount of this deflection is proportional to the weight of the mountain as compared with the weight of the earth.

Because of this fact, Maskelyne's two plumb bobs were deflected very slightly, each one toward the hill. Careful borings into the hill determined the average weight of its rock and this together with detailed surveys permitted the calculation of the hill's total weight. Knowing the latter, and the deflection of his plumb bobs, Maskelyne was able to calculate the earth's weight.

By modern scientific methods the earth has been still more accurately weighed, but Maskelyne's results were reliable enough to prove that the earth was far too heavy to be hollow or composed of ordinary rock, since ordinary rock weighs only about two and three quarters as much as water, while the earth as a whole was found to weigh five and a half times as much as water. Therefore the inside of the earth must be made of some heavier material than the outside, and scientists today agree that this material is probably a metal or a mixture of metals.

Another thing that scientists agree about today is that this metal core of the earth is not molten.

The Molten Earth Idea

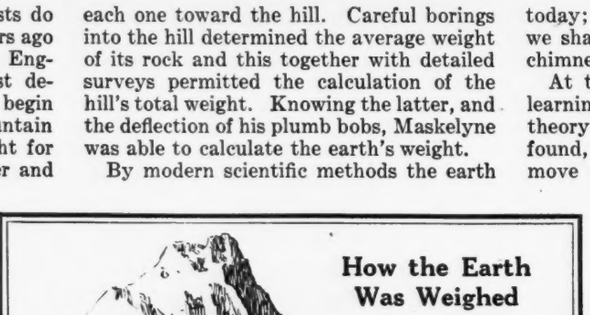
The idea of a molten earth originated, I suppose, from what men knew about volcanoes. When they saw molten rock burst out of the earth, they naturally thought that there was a vast reservoir of molten rock inside. Moreover, the once generally accepted "nebular hypothesis," concerning the origin of the earth, implied that there had been a time when our planet was a glowing liquid ball, and that it had gradually grown cold and hardened on the outside, leaving a fiery core within. But the nebular hypothesis doesn't agree with many unquestionable facts that we know today; while volcanoes are explainable, as we shall see, quite otherwise than as giant chimneys from a huge inner furnace.

At the same time scientists have been learning other facts that disprove the theory of a molten earth. It has been found, for instance, that earthquake shocks move through the earth as they would through a rigid body. Furthermore, the spin of the earth obeys the mechanical laws characteristic of a spinning solid ball, not of a liquid one. And, most convincing of all, are the facts about the tides.

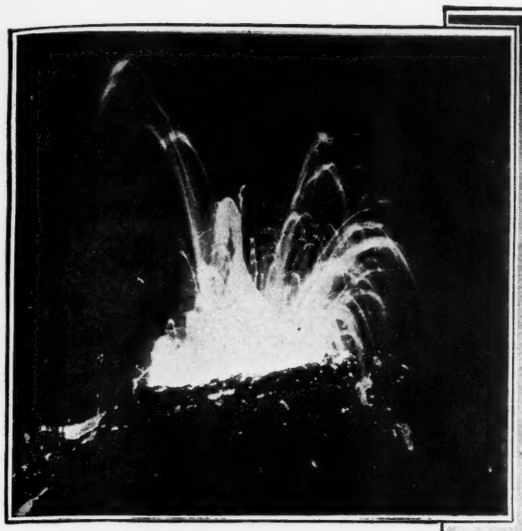
Earth Resists Tidal Pull

More than 50 years ago the great English scientist, Lord Kelvin, pointed out that an earth consisting of a thin solid crust surrounding a liquid interior would never be able to withstand the tidal pull of the sun and the moon. It is this pull of the heavenly bodies that makes the tides in the ocean. Now the pull is just as strong or stronger on the land. Why, then, are there not tidal waves in the solid ground as there are in the sea? Obviously, just because it is solid—because the land is too firm and rigid to yield to the tidal pull the way the water does.

Lord Kelvin figured out in tons the amount of these tidal pulls on the land. They were stupendous; many times larger than any possible resisting strength of the 50 or 60 mile crust then supposed to



NEARLY 150 years ago, in Scotland, the earth was first weighed. On each side of a hill, the weight of which had been estimated in advance by careful borings, was hung a plumb bob. Attracted by the mass of the mountain, these plumb bobs were deflected slightly from their normal vertical positions in line with the center of the earth. By measuring the amount of the deflection, which was proportional to the weight of the mountain as compared with the weight of the earth, it was possible to calculate the earth's weight, which was found to be much greater than it could be if the earth were rock all through



Flaming Lava at Night

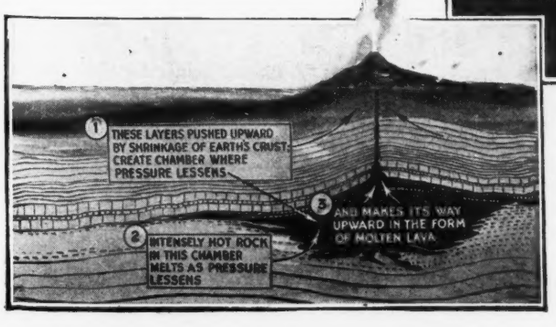
THIS remarkable night-time photograph of the flaming new cone of Mount Vesuvius, taken from the floor of the crater by Frank A. Perret, head volcanologist of the Smithsonian Institution, shows vividly a typical display of volcanic fireworks in the course of the mountain's recently renewed activity

constitute the only solid part of the globe. If we tried to live really on a thin rocky crust floating on a sea of liquid lava, we should not last one day. Inside of 24 hours the solid ground would smash under our feet. Twice each day a vast wave of melted rock, hundreds of feet high, would roll round inside the shell of the earth, bursting through it and overwhelming every vestige of anything solid.

There actually does exist, it is true, in the land as well as in the ocean, a tide; but it is a few inches high instead of hundreds of feet. It is the kind of tidal rise and fall that would happen in a very rigid solid—not in a ball of crusted liquid. We may be quite sure, then, that the earth as a whole is a huge solid ball, even more rigid than if made of the best steel clear through. If it was once molten long ago, as Doctor Washington believes, it must have cooled in the course of ages until it has become solid all the way through. But it is possible, on the other hand, that it never was molten at all, that it has always been as solid and rigid as it is now.

This view Professor Hobbs has lately brought out in his book, "Earth Evolution and Its Facial Expression," though he prefers the word "rigid"

(*Continued on page 30*)


1 THESE LAYERS PUSHED UPWARD BY SHRINKAGE OF EARTH'S CRUST CREATE CHAMBER WHERE PRESSURE LESSENS
2 INTENSELY HOT ROCK IN THIS CHAMBER MELTS AS PRESSURE LESSENS
3 AND MAKES ITS WAY UPWARD IN THE FORM OF MOLTEN LAVA

How Vesuvius Became a Roaring Smokestack

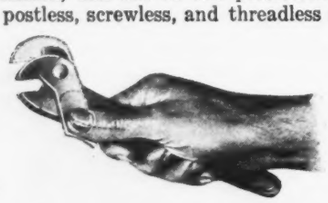
IN SUPPORTING the theory that the earth is a rigid sphere, with center of solid iron and rock, Dr. William H. Hobbs offers an entirely new explanation for volcanoes (see diagram at left). He suggests that shrinkage of the earth, pushing surface rocks upward into mountain ranges, forms low-pressure pockets comparatively near the earth's surface. With reduction of pressure the intensely hot rock in the pocket melts, and the molten rock rushes to the surface wherever it can, forming flaming volcanoes.

In the photograph above, scientists on the crater floor are shown measuring the temperature of the gases escaping from the lava

"The Story of Man and His World"

Threadless Wrench Holds Fast in Tight Places

WIDESPREAD demand for an end wrench that will adjust instantly and stay adjusted until the nut is loosened, has led to the perfection of a postless, screwless, and threadless de-



Thumb pressure engages or releases the teeth. Handle forms lower jaw

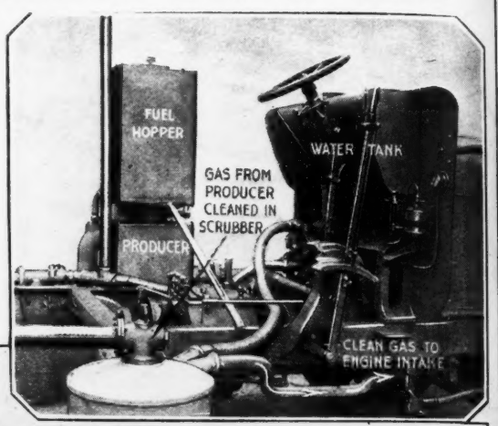
vice that combines light weight and great strength. In designing this wrench the manufacturers have eliminated all excess bulk in the head, thus making it possible to use it in tight places.

The handle forms the lower jaw and is notched at right angles to the gripping face, while the movable upper jaw is also notched and can be moved up or down when the notches are pulled out of engagement. When the thumb of a hand holding the wrench presses the corrugated part of the movable jaw, disengaging the teeth, the upper jaw will move instantly up or down to the proper adjustment. Pulling back on the jaw with the thumb again engages the teeth.

Motor Truck Runs on Coal or Corn

TO BEAT the rising cost of gasoline, British manufacturers have perfected a motor driven by gas formed by blowing a steam jet through a bed of burning coal, charcoal, or corn, or any material rich in carbon, and generated while the vehicle is in motion.

Heat from the fuel produces steam, which is then forced into the firebox. Carbon monoxid gas is a result. This gas is admitted to the engine cylinders.



The new producer gas truck, showing engine, generator, and fuel hopper

What Is Inside the Earth?

(*Continued from page 29*)

to the word "solid," for rigidity is only one of the properties of solids. Under the tremendous pressure and temperature inside the earth, it is possible that the properties of matter are not the same as we know them on the surface. Things may be "rigid" and still lack some other property of "solids." Professor Hobbs explains the origin of such a rigid earth among the blazing, gaseous stars of space by reference to a new theory of how the earth was formed—the so-called "planetesmal hypothesis."

This hypothesis begins by imagining the sun as a single star, a little larger and hotter probably than it is now. There were no planets sweeping around it then. Along came another star. It happened to pass so close to the sun that the gravitational attraction between the two bodies pulled out a lot of matter from the sun.

These enormous pulled-out "drops" of matter began to revolve about the sun. In time, as they collided with one another, sticking together when they struck, they gathered into great lumps. These lumps are the planets we know today—Venus, Mars, and the others; also the earth.

Explaining the "Planetesmal" Theory

The visiting star left behind a sun surrounded by a vast revolving cloud of matter that had been torn out of it.

In this cloud were millions of small lumps of matter—called "planetesmals," or baby planets. One of them, a little larger than the others, became the nucleus of our earth. It picked up the smaller lumps that happened to be revolving about the sun in the same general path. Think of a molasses-coated baseball flying through an endless swarm of gnats.

In the course of time—millions on millions of years—the earth picked up nearly all the baby planets within its reach. That is the condition now. A few small bits of matter, which managed to escape before, are still being picked up occasionally. These are the meteorites that we see shooting over the housetops at night.

World Built by Meteors

Now scientists who are studying these meteorites that still arrive on the earth, note that they are of two kinds. Some are iron and some are stony. The latter consist of rocks much like the rocks on earth.

Of the vast original cloud of matter pulled from the sun, Professor Hobbs—whom I mentioned above as the most recent advocate of the iron-core theory—thinks about half consisted of iron lumps like these iron meteorites, and about half of rock lumps like the stony ones. They were continually hitting each other like grains of sand in a storm. From mathematical calculations, the professor concludes that the larger lump that was to become the earth would pick up at first a pretty fair average of smaller lumps, about as many iron ones as stony ones. A little later, when the crowd had been thinned somewhat, it would pick up mainly iron lumps. Later still, it would pick up mainly stony ones, as the earth is doing today—for iron meteorites now are rare.

You can see what sort of structure the earth would have under this theory. At the very center is the original nucleus; next is a zone of half iron and half rock; then comes a zone that is almost pure iron; and the outside is a rock zone—the visible crust of the earth today.

But the theory, as it stands, seems to leave us still mystified about those fiery, death-dealing smokestacks of the earth—the volcanoes. In scores of places on the earth's surface, millions of tons of melted rock are still being hurled out from the earth's interior. Whence comes all this fire and steam and molten stone?

Professor Hobbs answers with an entirely new explanation of volcanoes. He says that volcanoes are caused by a sudden melting of a small pocket of rock comparatively near their surfaces.

To begin with, the inside of the earth, while not molten, is known to be intensely hot. Even at a depth of only 50 or 60 miles—less than one eightieth of the distance to the center of the earth—the rocks are so fearfully hot that they would melt at once if it were not for the tremendous pressure of the mass above them. This pressure keeps the heated rock from melting, just as the pressure in a steam boiler keeps the water from all flying off as steam.

Rocks Melt as Earth Shrinks

But if you open the top of the boiler and relieve the pressure, the water *will* all fly off as steam. And similarly, says Professor Hobbs, if you pry up some of the outer layers of the earth's crust, thus relieving the pressure on the hot rock inside, this rock will promptly melt. Now the earth is constantly—if very slowly—shrinking in size. As it shrinks, the surface rocks are pushed up into folds and wrinkles like the wrinkles on a dried-up prune. These become mountain ranges. Under each of them the weight of the rock is lifted a little, the pressure on the deeper rocks is decreased, and these rocks quickly melt. Whenever it can, this melted rock finds its way out to the surface and a new volcano is born.

Thus, whether we accept the iron core theory of the earth's interior, or the new gold core theory, we may at least go about our affairs on earth secure henceforth in the belief that we have the solidest conceivable footing underneath us; and that the awe-inspiring outbursts of volcanoes are merely local accidents instead of being, as people once thought, the grim mutterings of some vast, fiery inner cavern lurking right below our feet and threatening in some monstrous future catastrophe to engulf us all.

"The Story of Man and His World"

The Most Fascinating Serial Ever Published in a Magazine

YOU will read in POPULAR SCIENCE MONTHLY during 1923 the most important serial ever published in a magazine. You will enjoy the most fascinating and thrilling story that could be told. It is a tale more absorbing than fiction could ever be. *And every word of it is fact!* It is "The Story of Man and His World."

It Begins in the Next Issue of Popular Science Monthly

THIS unique serial, by Dr. E. E. Free, tells the marvelous romance of life itself. It is Science's own story of how our world came into being, of how life appeared and developed upon it, and of how the amazing drama of Evolution led, at last, to the birth of Man. It is a story of spectacular events that covered more than a thousand million years—a time so vast that all the centuries of recorded human history are "but a few seconds" beside it.

Never before have you been able to read this wonder story of "Man and His World" in one simple, continuous narrative. Dr. E. E. Free—scientist, traveler, engineer, and one of the best writers of popular science in America—has revealed, in words made plain for everybody, the great secrets of science and life hitherto beyond the grasp of the average man.

ACROSS the pages of this great serial march prehistoric lizard-like monsters—twice as tall as elephants, more terrible than the fiercest tigers. And dodging fearfully beneath their feet run a few tiny, ratlike creatures destined to outlive the freak monsters they fear and to become the ancestors of nearly all modern animals, including man himself.

In a still more ancient scene of the story you will see a tiny "wormlike thing" trying to make his way up the bottom of a river against the current, trying patiently generation after generation, century after century, until he finally "invents" something that enables him to succeed—a rod of gristle down his back. What did he do, this little striving worm of five hundred million years ago? He invented the backbone, one of the greatest of all steps in the evolution of man!

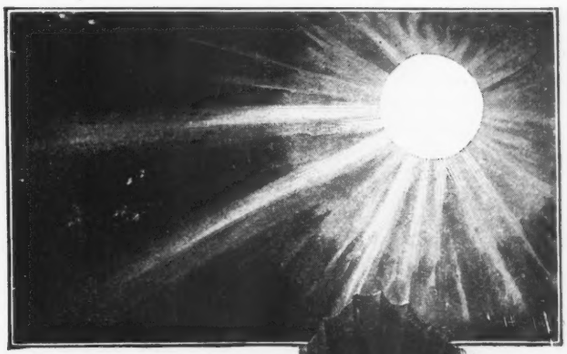
Still farther back, in the dimmest mists of time, you will see a world absolutely devoid of any life except tiny pear-shaped drops of jelly with hairlike stems. These, you will learn, were the first ancestors of all life.

Facts You Need to Know

How much of this story do you know? Can you afford not to know more of it, if you are to call yourself well informed in this Age of Science?

Do you know that once there was an insect-eating ancestor of man who looked about half like a dog and about half like a cat? Do you know that in far off Madagascar there still dwell descendants of this humble "cat-dog" creature? Or do you know how the marvels of the human body develop from a single speck of living matter, a single cell so small that you can see it only through a powerful microscope? Do you know that certain similar one-celled things live always inside our own bodies as separate creatures—the white blood corpuscles that attack and eat disease germs?

Innumerable fascinating facts like these go into the making of Doctor Free's great story. It is a magnificent panorama of science.



Above: Our world in its infancy, perhaps ten billion years ago—a huge, flaming, lifeless ball, and below, some of the spectacular characters from Doctor Free's great story of life on earth

Above: One of "Nature's jokes," from the "Age of Reptiles." Below: The most terrible creature that ever lived—*Tyrannosaurus Rex*

Below: The woolly mammoth, a contemporary of prehistoric man

Below: The earliest known human form, the Ape-man whose bones were found in Java

At right: The gorilla, man's nearest animal cousin

Don't miss this wonderful story, which begins in our next issue

Deep Sea Thrillers in Natural Hues for the Movies

Gorgeous Life on Ocean Floor to Be Thrown on the Screen

ALL our ideas of the bottom of the sea as a dark, colorless dungeon are now to be dispelled, with the announcement that J. E. Williamson, famous creator of undersea movies, is considering plans to use when possible the new color movie process perfected by Dr. Daniel Frost Comstock in photographing in all its gorgeous colors the little known animal and plant life dwelling in shallow waters below the ocean's surface.

An Undersea Pioneer

Williamson, the one motion picture producer who has invaded the ocean floor, already has recorded on black-and-white films many wonderful and thrilling marvels of submarine life that are entirely new and strange to us. Now, when color films are perfected, he is satisfied that even those of us who know in a general way what the bottom of the sea looks like will gasp in amazement when we see the natural brilliancy of those mysterious depths—the "land" where plants flourish, flowers bloom, and undersea life flashes in all the colors of the rainbow.

Williamson has made thousands of daring voyages to this land, particularly in the vicinity of the West Indies. He knows its out-of-the-way places. For the black-and-white movies he has staged there thrilling scenes before the camera—battles between divers and man-eating sharks, adventurous searches for sunken treasures, and "mermaids" frolicking through deep sea forests.

Men and Camera Dropped into Ocean

An artist and newspaper photographer, Williamson first utilized an invention of his father's to take movies under the surface of the water. This invention consists of a steel, glass-faced, watertight chamber in which it is possible for a photographer to operate a movie camera. By means of flexible sections this chamber is lowered from a vessel to great depths. Overcoming hundreds of difficulties, Williamson produced the first undersea movie—"The Williamson Submarine Expedition"—and later Jules Verne's "Twenty Thousand Leagues Under the Sea." His latest exploit was to film with the slow camera the swift movements of man-eating sharks and other undersea inhabitants.

When color movies can be applied to the sea depths, he says that:

Islands of coral, which until now have appeared on the screen as gray masses of beautifully shaped plant and tree formations, will be reproduced in their natural colors—blues, pinks, and reds. Deep sea mosses and ferns will be seen in gorgeous greens. We shall see fishes of all shades and forms—the brilliant weakfish, the pink pompano, the variegated moonfish, angel fish and sailfish, the mottled tarpon, the chameleon-like moray, which changes its color like tricolor silk, and the monster gray shark.

All this we shall see in a glow of spectral bluish light that illumines the ocean depths.

The remarkable results of the first successful color movie process are fully explained for the first time on page 59 of this magazine.

New Color Photography Will Show Strange Plants and Fishes

How J. E. Williamson photographs thrilling scenes at the bottom of the sea, operating his movie camera in a watertight, glass-faced chamber, lowered from a vessel at the surface. Great depth is obtained by means of a flexible and collapsible tube supported by steel rings

Marvelous new underwater photographs taken by J. E. Williamson off the West Indian islands. They show divers attacking some monster of the depths; a "mermaid" gathering "flowers" in a garden on the ocean floor; gorgeous forests of living coral, hiding strange, many-colored inhabitants

Staging a Deep Sea Film

A thrilling battle with a man-eating shark at the bottom of the sea is pictured here as it will be shown in the proposed new undersea color movie. Williamson has actually photographed a similar battle for black-and-white movies now being shown

Seven-Ton Retort Scrapped by High Explosive

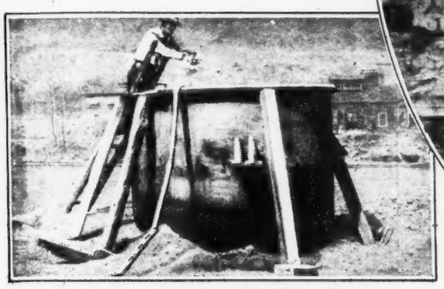
THE use of high explosives to scrap bulky and unwieldy iron receptacles or machines that have been discarded is replacing the cumbersome method of lifting them entire on cars and hauling them away to be melted.

The scraps into which the receptacle or machine is shattered by the blast are not only easier to load on cars, but they also take up less room and thus conserve car space.

A manufacturer of explosives recently demonstrated this method of reducing useless iron receptacles to scrap. A seven-ton nitric-acid retort, six feet high, was filled with water and six quarter-pound charges of 60 per cent explosive gelatin, fitted with electric detonators, were suspended in the water.

When the charges were fired, a huge geyser of water rose from the shattered retort, while the fragments of the vessel fell within a radius of only 25 feet. The factor responsible for confining the flying fragments to such a limited space was the water that filled the retort and in which the explosive was placed, for this reason:

Water is practically incompressible. Therefore, when the gelatin was exploded in the water, the expansion was instantly transmitted to the sides and bottom of the retort in sufficient force to crack them into pieces. But since the top of the receptacle was open, the greater part of the explosion force spent itself upward, producing a tall geyser of water. The shattered fragments of the receptacle, on the other hand, fell only a few feet.



Setting the charge. Into the seven-ton retort, filled with water, are dropped six small charges of explosive gelatin

The explosion. Much of the force of the charge spends itself in the form of a towering geyser

The remains. Fragments of the shattered retort, confined within a 25-foot radius, are easily loaded on cars

Engineers Make Mississippi River Bed Autograph Its Profile

AN AUTOGRAPHIC sounding machine that makes it possible to obtain a detailed and accurate profile map of a river bottom as rapidly as a towboat pulling a barge can move along the line of soundings, has been developed by M. Meigs, Corps of Engineers, U. S. A., and is being used by government engineers to chart snags, shoals, and rocks on the upper Mississippi River.

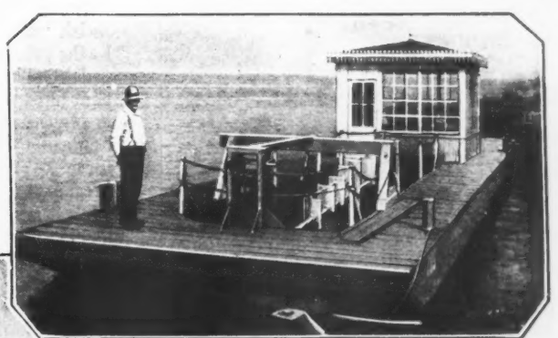
The essential part of the mechanism is a sounding arm, the lower end of which drags along the bottom of the river, following the contour of the river bed. The upper end of the arm is connected with a recording device located on a barge. Vanes attached to the arm oppose the water in such a way as to force the end of the arm down to the river bed.

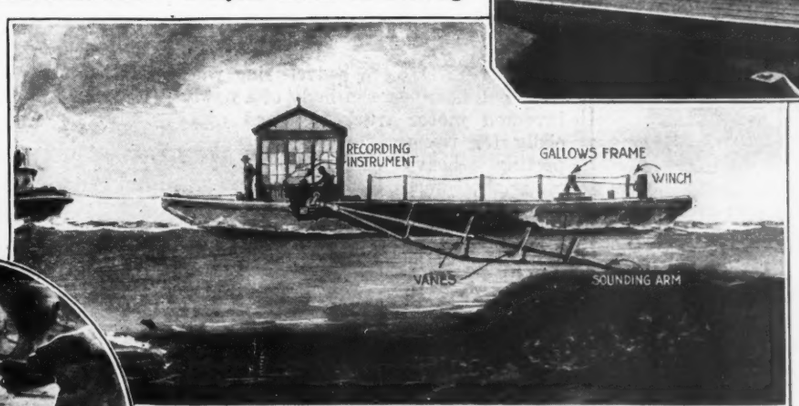
As the barge, equipped with sounding arm and recorder, is towed along the river, any elevation or depression of the river bed causes the arm to move through angles corresponding to changes in elevation. A quadrant attached to the upper end of the arm moves through an equal angle and this motion is transmitted by a thread to the recorder. Here a stylus marks on charting paper the amount of movement of the thread. By means of a graduated scale, every change in the distance of this mark from a base line can be interpreted as indicating a definite angular displacement of the sounding arm and hence a definite change in elevation of the river bottom.

Since the recording paper is moved across the stylus at a rate corresponding to the speed of the barge, the stylus produces a jagged line along which horizontal distances indicate miles covered, while vertical distances indicate elevations of the river bed.

A valuable feature of this mechanism is that the nature of the river bottom is also recorded. Gravel, sand, mud, rock—all reproduce their peculiar handwriting on the chart.

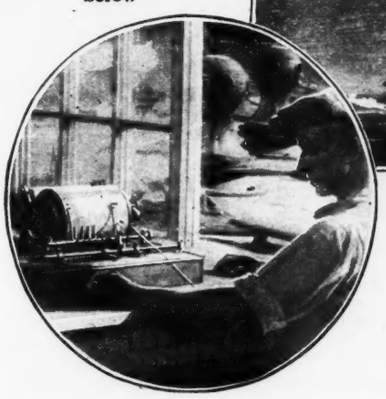
Hidden snags are also revealed; dangerous boulders are located. Indeed, the complete record of the river bottom on which the sounding arm is dragged, is obtained on the recording strip of paper.





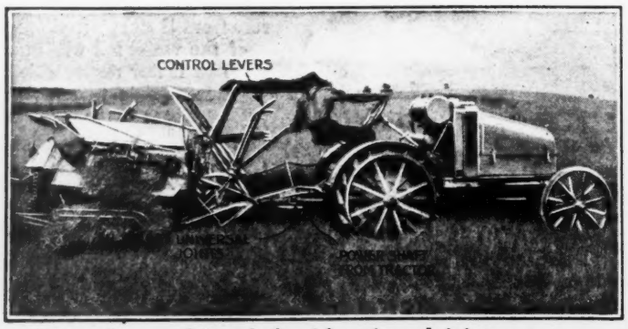
Above is shown the barge, equipped with sounding and recording mechanism used by government engineers in making profile maps of the river bed along the upper Mississippi. The operation of the machine is shown at left. Note the vanes that steady the lower end of sounding arm on the river bottom

As the barge is towed along a river, every movement of the sounding arm, following the contour of the river bed, is transcribed on charting paper by a stylus. The recording instrument is shown below



Tractor Drives One-Man Grain Binder

OPERATED by one man, a new power driven grain binder, developed by a Chicago implement manufacturer, cuts a 10-foot swath and harvests from 30 to 35 acres a day. It is said to mark the greatest step since the invention of the binder in the seventies.



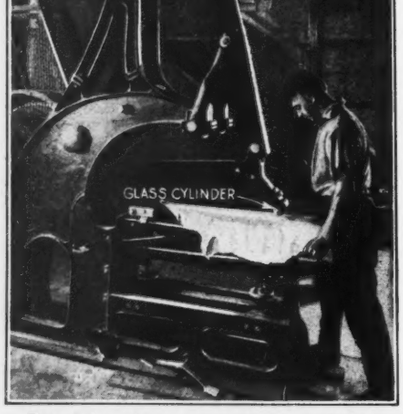
Through a revolving shaft with universal joints, power is delivered from the tractor to the binder that it hauls

The machine differs from other binders in that the power for operating the binder mechanism is derived, not from the main wheel, but from the tractor that pulls the binder. This power is delivered from the tractor by means of a revolving shaft with universal joints that make it possible to cover very rough ground. The arrangement enables the binder to be run at more uniform speed, and the steady flow of power from the tractor makes it possible to cut a wider swath than with the ordinary binder. The direct positive drive prevents slipping and choking where conditions for cutting are unfavorable.

Should the binder become choked, it is necessary only to stop the tractor. The power drive continues to operate the binding mechanism and the binder automatically clears itself. It is claimed that the machine doubles the acreage that can be harvested by one man, greatly increasing his efficiency.

How Rough Hides Become Glossy Leather

THE process by which the raw hides of animals are transformed into leather is far more complicated than most people realize. After the hides reach the tannery, they are cleaned of blood and dirt and then softened by soaking and mechanical treatment. Then the hides are treated with lime, by which, with the aid of bacterial action, the hair is so decomposed that it is easily scraped off, together with the skin. At the same time the "net skin" on the flesh side of the hide is removed by scraping and shaving.



Pressed under a moving glass cylinder, the leather receives its glossy finish

After the hides are "dressed," they are "scudded," a process of scraping to remove lime, hair, flesh particles, pigment cells, hair sacs, and soluble hide substance. Concluding with a thorough rinsing, the hides are ready for the tanning process, which varies according to the kind of skin and the purpose for which the leather is to be used. Having gone through the tanning process, the hides are scoured and then oil and grease are worked into the skin.

Heavy leathers are usually ready for the market after they have been tanned and have been through the subsequent "currying" process, but the light leathers are often dyed, stained, grained, or embossed before they are marketed. Slow working acid dyestuffs and direct cotton dyes are the most satisfactory. The leather is either dyed in a manner similar to the dyeing of cloth, or the dye is applied to the surface with a brush.

Some leathers retain the rough dull finish with which they come from the dye bath; others are given a smooth and glossy finish. This is done with a machine such as that shown in the illustration. The leather is placed on a bed, and is pressed against a glass cylinder, which is run back and forth over the leather with considerable pressure. This completes the process.

Bread Loaves Measured to Standard by Seeds

HOW Uncle Sam is continually on the alert to prevent you from being "short weighted" when you purchase food is shown by the recent adoption of a bread measuring device by the Bureau of Agricultural Economics.

The displacement principle is employed, the volume of a particular loaf of bread being measured by the uniform flow of flaxseed into a graduated tube. The bread is placed in a container and the flaxseed is allowed to flow around it, completely surrounding the loaf and filling all the crevices almost as completely as would water. The difference between the amount of seed required to fill the container when the bread is in it, and that required when the bread is removed measures the volume of the loaf.

© Harris Ewing

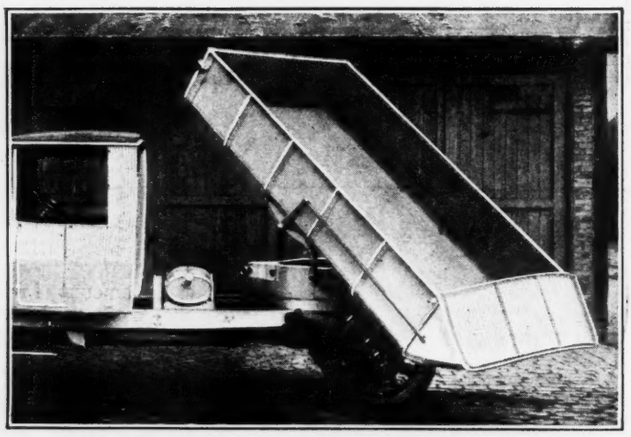
By the uniform flow of flaxseed in this apparatus, Uncle Sam measures the size of loaves

The flow of seed into a funnel below the container measures in cubic centimeters.

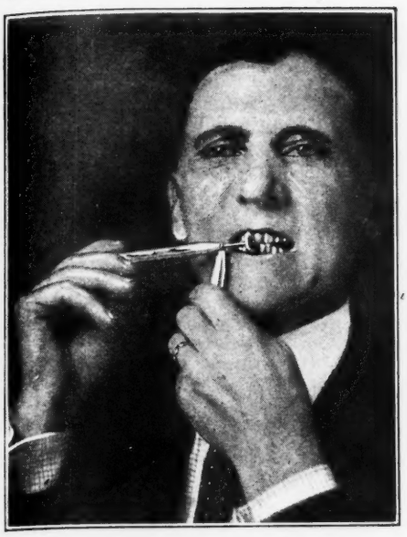
Dump Truck Has Swiveled Tilting Body

MOUNTED on a swivel ring with ball bearings, the body of a newly invented motor truck, designed especially for transporting heavy materials, such as coal and rock, can be rotated so as to discharge its load either backward, on either side, or in any direction between these angles. The capacity of the body is 5½ tons.

The ring mounting is equipped with a gear for tilting the body for discharging its load. The gear for operating the swivel and for tilting the body is driven by the gasoline engine that propels the truck.



This swiveled body can be tilted in any direction



Rotary Brush for the Teeth

MORE thorough cleaning of the teeth is made possible by a small circular brush rotated by turning the sanitary handle to which it is rigidly fastened. The position and pressure of the brush on the teeth are maintained by a second handle through which the shank revolves.

New Shingles Interlock over Old Roof

INTERLOCKING asphalt shingles which, the manufacturers claim, will not warp, curl up or blow up in wind or storm, have been designed especially for reroofing old wood shingle roofs without the necessity of tearing off the old shingles.

The interlocking feature permits single-layer roof construction.

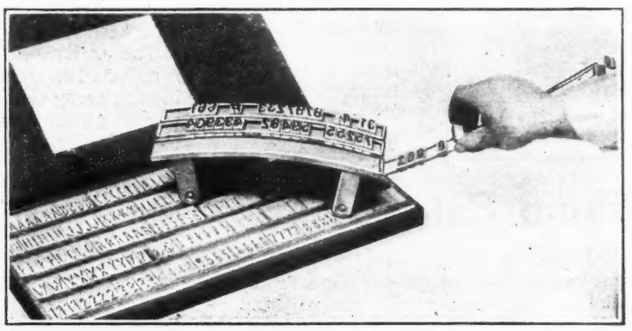
Interlocking of these shingles is accomplished by means of slits cut in both sides of each shingle two inches above the butt, as illustrated at the right. Into these slits fit the edges of adjacent shingles. Tab points formed by the slits lock tightly on the under side when the shingles are nailed down. The shingles are made in various colors.

These interlocking shingles can be laid over an old wooden roof in the manner shown above

Type Setting Made Easier

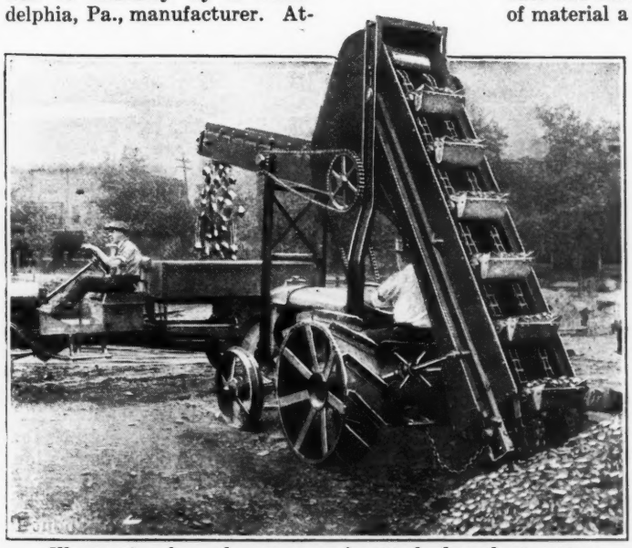
A RUBBER stamp printing outfit by which the operator can set type without having to read the letters or figures backward has been perfected by a San Diego, Calif., manufacturer.

The type units are placed in a hinged wire frame that forms the face of the stamp. This frame is swung away from the face and in it are placed the type units, on which are printed the letters as they will be read.



Tractor Elevator Loads a Ton a Minute

A PORTABLE elevating loader, operated by and mounted on a Fordson tractor, is a recent contribution to industry by a Philadelphia, Pa., manufacturer. Attached to a regular Fordson tractor and taking its power from the power shaft of the tractor, the loader is said to elevate and load more than a ton of material a minute.



Illustrating how the conveyor is attached to the tractor

The material is picked up and elevated by buckets attached to an endless chain and is dropped upon a conveyor that runs in a trough over the top of the tractor. This conveyor drops the material into trucks drawn up in front of the tractor. The tractor backs into the pile of material to be loaded so that there is a continual supply for the elevator.

Safety Fender Puts Brakes on Descending Elevator

AN AUTOMATIC safety fender for freight elevators has recently been devised by a large manufacturing concern to safeguard operators from being crushed to death by descending cars.

The invention consists of a control bar attached beneath the floor of the car and connected with the elevator driving mechanism in such a way that the instant the bar strikes any obstruction it automatically shuts off the power and brakes the car.

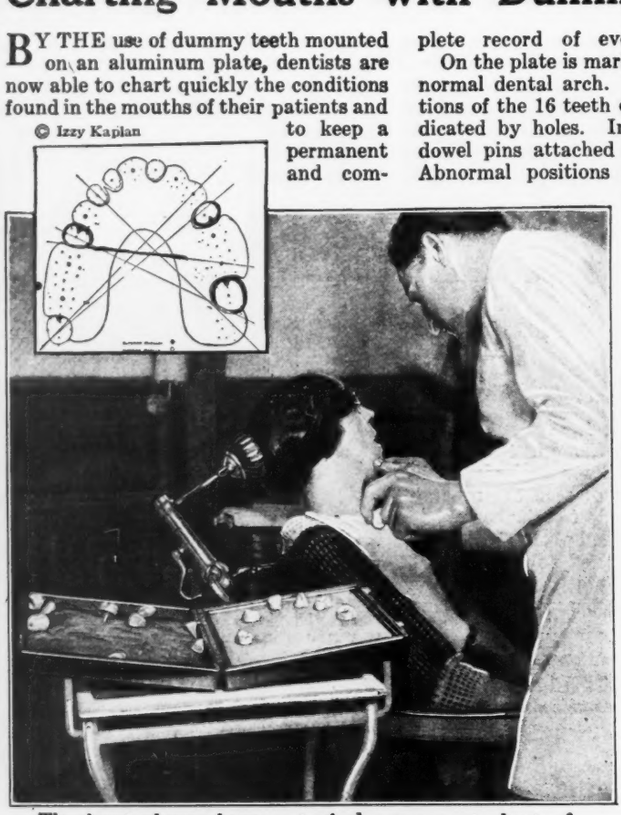
Striking a workman's head, the fender bar automatically brakes the descending elevator

Thus if a workman should be leaning over the shaft door with his head and shoulders in the shaft, the safety bar of a descending elevator, striking his head, would immediately brake the car and bring it to a stop before the pressure could become great enough to crush him.

Charting Mouths with Dummy Teeth

BY THE use of dummy teeth mounted on an aluminum plate, dentists are now able to chart quickly the conditions found in the mouths of their patients and to keep a permanent and complete record of every case treated.

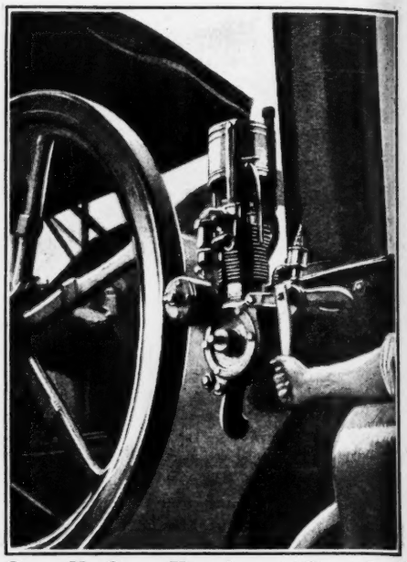
© Izzy Kaplan



The inset above shows a typical permanent chart of a patient's teeth, made by means of the dummy teeth

On the plate is marked a diagram of a normal dental arch. The normal positions of the 16 teeth of each jaw are indicated by holes. Into these holes fit dowel pins attached to dummy teeth. Abnormal positions of the teeth are reproduced by inserting the dowels of the model teeth in other holes provided for that purpose.

A permanent record of each case is made on charts on which the position holes of the planning plate are marked. To make a record, a chart is placed on the plate so that the dots coincide with the holes. Then the dowels of the dummy teeth are inserted into the respective holes through the chart. The chart is then filed for future reference that will save much time.



Small Gas Engine "Cranks" Large Road Roller

USING a small single cylinder gasoline engine to start a large one, a concern in Harvey, Ill., claims to have solved the problem of turning over the crankshaft of a large road roller engine. Heretofore electric motors and compressed air starters have been used.

The small air cooled single cylinder motor is mounted on the frame of the larger engine in such a way that the friction pulley of the smaller motor presses against the flywheel of the larger engine. The operator starts the small engine by hand, and then by pressure on a lever, brings the small wheel in firm contact with the large one. As soon as the large motor has started, the smaller engine is stopped.

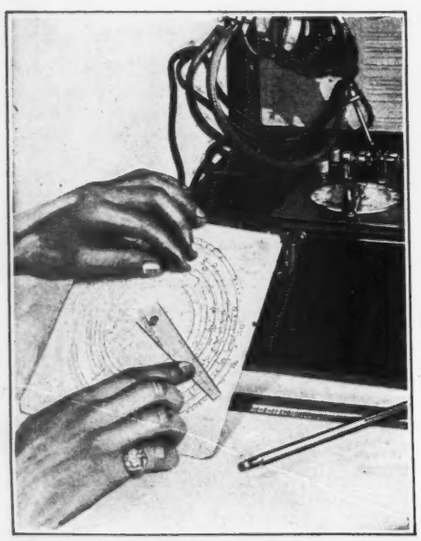
Slide Rule Makes Radio Calculations

THE recent invention of a circular radio calculator or slide rule, by Raoul J. Hoffman, noted aeronautical engineer of New York City, has assisted greatly in the design of wireless sets, eliminating the tedious method of computing values for inductance, capacity, and other necessary figures by means of formulas.

The calculator consists of a cardboard base, on which are mounted a circular cardboard dial and transparent celluloid pointer, and has in all, 29 scales graduated in the units used.

Thus, to compute inductance of a coil 4 inches long, 5 inches in diameter, wound with No. 20 double cotton covered wire, the two scales of length and diameter of the dial and base respectively are adjusted so that the proper figures are superimposed. The celluloid pointer is then moved to DCC 20 and the answer, 2700 microhenrys, is read on the dial.

Vice versa, if the inductance were known, the coil dimensions could be determined.



Radio calculations are made by adjusting circular dial and celluloid pointer

OFFICIALS of the Bureau of Animal Industry say that there were twice as many cases of rabies during the year ending June 30, 1922, as the year before, and point to the fact that many of the cases occurred during the seasons when dog-muzzling is not required by city ordinances.

Civil War Sniper's Rifle Comes Back

THE sniper's ponderous rifle of Civil War days has returned in the form of a super-accurate rifle made by the Winchester Arms Company for the United States Government and used by the 1921 Olympic team in defeating the Swiss riflemen for the first time in a score of years. The Civil War weapon was used only for sharpshooting, for it was so heavy that it had to be transported in a wagon and shot from rest. The barrel was made unusually heavy to overcome the whipping action or "jump" of the gun.

Capt. W. H. Richard, world famous rifleman, shooting the heavy barreled sniper's rifle that he invented

In 1915, Captain William Richard, one of the world's greatest riflemen, conceived the idea of applying the old, heavy barrel principle to a modern high power rifle. He obtained two barrels, one rifled with six, and the other with four, grooves. These he mounted on a Springfield stock. Experiment resulted in modifications, and the present product is an 8-pound barrel 26 inches long tapering from 1⅛ inches diameter at the chamber to ⅞ inch at the muzzle. While this type of rifle weighs about 11 pounds, the weight is well distributed.

Floating Cradle Lays Jointed Pipe across River Bed

BY THE ingenious use of a timber cradle 150 feet long, suspended between two moving barges, engineers recently set new speed records in submerging thousands of feet of flexible joint, 30-inch cast iron pipe under three rivers that cross the route of a 20-mile water supply line running into Norfolk, Va.

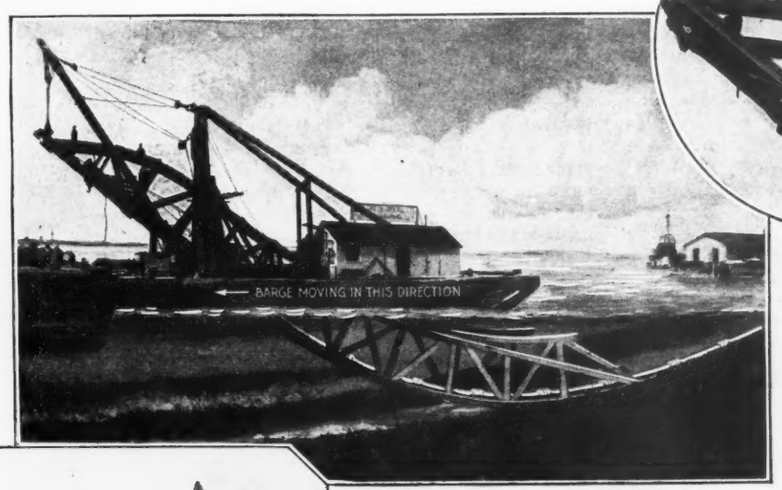
The timber cradle was hung so that the lower end moved along the river bottom, while the upper end projected above the barges. The pipe sections were joined one after another at the upper end of the cradle, and as the barges moved slowly forward the jointed pipe slipped down the curved skidway of the cradle to the river bottom.

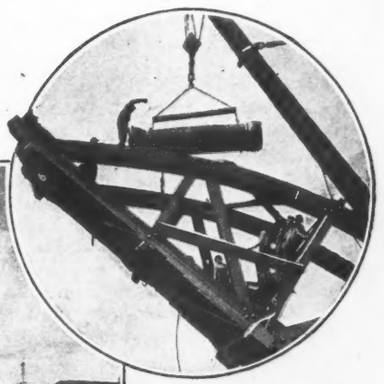
The total width of the three rivers under which the pipe was submerged in this manner was nearly two miles, and the pipe was lowered to depths ranging from 20 to 85 feet.

Before the pipe was laid, trenches were excavated across the beds of the streams and the irregularities in each trench were eliminated by pulling a rectangular drag, weighing three tons, along the bottom by cables.

The lower end of the pipe laying cradle was kept in contact with the river bottom, whatever the depth of water, by raising or lowering purchase blocks and tackle by which the cradle was swung from the two barges.

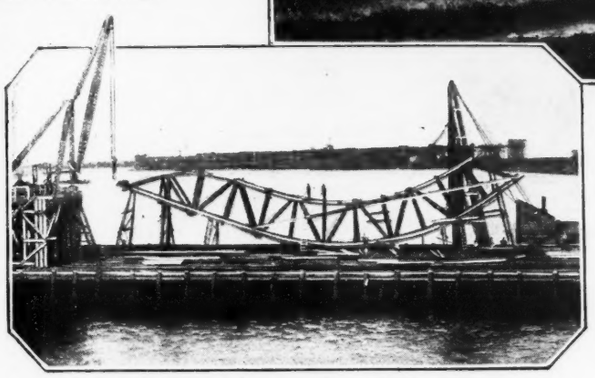
On the derrick barge a special pot was swung from a furnace to the cradle and from this pot each joint was poured. As soon as the lead was poured and before the bell of the pipe joint had cooled, the joint was carefully caulked and then chilled. After the bell had cooled, the joint was "broken" to allow the pipe to conform to the curve of the cradle. The entire pipe laying rig was then moved forward and the pipe allowed to slip down as the cradle advanced.





At the upper end of the cradle (above) pipe sections were laid one by one and joined. Then, as the barges supporting the cradle moved forward, the jointed pipe slid down a curved skid to a trench at the river bottom, as shown at left

Photo courtesy *Engineering News-Record*



The 150-foot timber cradle used in submerging pipe across three Virginia rivers

Coloring the Wood of Living Trees

FURNITURE manufacturers in Germany have developed an ingenious method of dyeing the wood of living trees instead of waiting until the tree is cut down and sawed into lumber to apply the coloring.

A solution of the dyestuff in water is supplied to the roots of the tree through a tube from a tank suspended from the trunk at a height of 10 or 15 feet. The dissolved dyestuff, absorbed by the roots, is conducted with the sap, through the long cells of the wood in trunk and branches, to all parts of the tree, including the foliage. The solution passes from cell to cell through the inclosing cell membranes by osmosis—that is, the tendency of fluids to pass through porous partitions and mix—and imparts a uniform color to the wood fiber.

A tree from 60 to 70 feet high requires approximately four weeks to become thoroughly permeated by the dyestuff. Then it dies and is cut down to be sawed and seasoned into lumber suitable for furniture making.

Not every dyestuff can be used in this method, for unless it forms a true solution, it will not pass through the membranes of the wood cells. A similar method has been suggested for impregnating the wood of living trees with preservatives that would prevent their mature decay. This method means a considerable saving in labor and expense over former processes.

From a tank suspended on the tree trunk, the dye solution is carried through a tube to the roots

Trap Harpoons Animals

BASED on the principle of the harpoon, a new spring gun for trapping fur-bearing animals, has been designed by Mr. V. M. Brown, of Medicine Lodge, Kans.

The trap includes a barrel in which is mounted a spear that is driven downward by a coiled spring concealed within the barrel. This spear is normally concealed and held by a trigger to which is attached a long rod terminating in a bait hook.

When the animal pulls on the bait, the spear is automatically released and driven into the animal by the force of the spring.

New Stagecraft Lifts Scenes through Floor and Paints Them with Light

Revolutionary Playhouse-Amphitheater without Aisles Created by Young American Designer

IMAGINE yourself entering a square theater without aisles, and in which the stage, instead of being "framed" like a picture, at one side of the auditorium, juts out from a corner, presenting a wide circular front to the audience. No stage curtains, back drop, or orchestra pit are in sight—just a bare, colorless platform, separated from the spectators only by a low flight of steps.

Arranged in quarter circles concentric with the curve of the stage front, widely separated rows of seats form an aisleless amphitheater. Above, a domed ceiling extends over both the audience and the stage site. There are no balconies.

You reach your seat by passing along the wide space that separates your row from the row in front. And as you do so, from somewhere come strains of music from a hidden orchestra, sounding as if the orchestra were directly in front of you.

A Stage Suddenly Appears

The lights go down. Then all at once the stage appears in a blaze of light, the source of which you cannot trace. You are amazed to see before you a complete stage with scenery where, but a few seconds before, only a bare platform was visible. The play begins and—thrilled by the spectacle before you, a flashing, changing, melting riot of color—you seem to have been made a part of it, by some mysterious agency that you can't understand. The act ends, and as the lights go up, you are strangely aware of the bare platform, where the stage, with its gorgeous scenic effects, had been only a moment before.

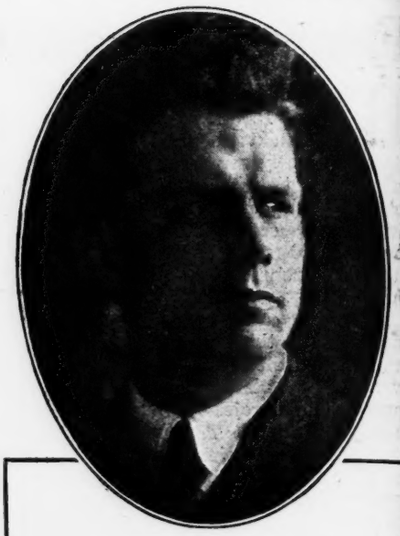
Such is the revolutionary new theater designed by a brilliant young creator of stage settings, Norman Bel Geddes, of New York City. Use of the marvelous scientific lighting effects, lately perfected, has been limited hitherto by the design of theaters built for old-fashioned stage settings. Mr. Geddes has now designed a theater especially to give full scope to these modern lighting methods.

Until recent years our stage scenes, framed by the confining opening of the proscenium, produced the effect of a two-dimensional picture—that is, the settings lacked full natural perspective. It is to release the actor and playwright from this serious handicap that Geddes and other younger artists of the stage have been devoting their efforts. Theaters of this type have already been planned for construction in Los Angeles and other cities.

The scheme conceived by Geddes is simple enough. The seats are confined to the main floor and a few boxes or stalls at the rear of the auditorium. The audience is literally seated around the stage, and, strange as it may seem, even though the concentric rows of seats are separated by 4½-foot spaces between chair back and chair back, Geddes' plan actually provides more seats and a deeper stage than does a theater with orchestra, balcony, and gallery.

Since the stage is actually projected into the audience, none of the present cumbersome devices for settings, such as curtains and drop, is required. The stage platform, which supports the scenery, is lowered or raised into place by hydraulic plungers. When, at the close of a scene or act, a change of scenery is required, the entire stage setting is lowered into the basement, and rolled from the platform into an alcove provided for it. Then the new setting is rolled onto the platform, which is raised to the auditorium. The hydraulic plungers will lower or raise a stage in 12 seconds.

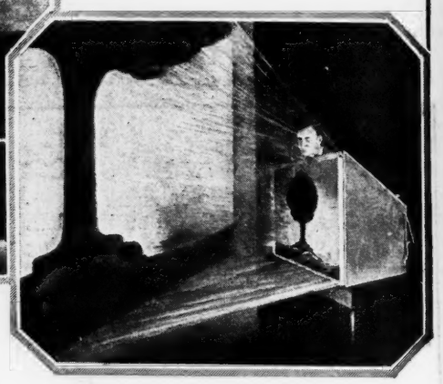
Immediately beneath the inclined floor of the auditorium, on the level of the street, is a floor that is occupied by a large



Norman Bel Geddes

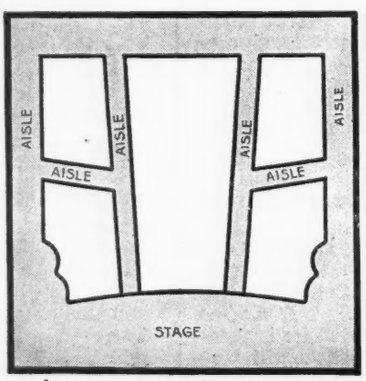
EQUIPPED with six months' training in art school, Norman Bel Geddes, of New York City, is one of the greatest modern designers of stage settings. For this profession his schooling consisted chiefly of enthusiastic study of stagecraft.

This young American designer of the revolutionary new theater made his start by writing a play and designing the settings. Now he is endeavoring to remove the limitations that surround the American stage. Theaters of this general design have been planned for Detroit, Cincinnati, and Los Angeles

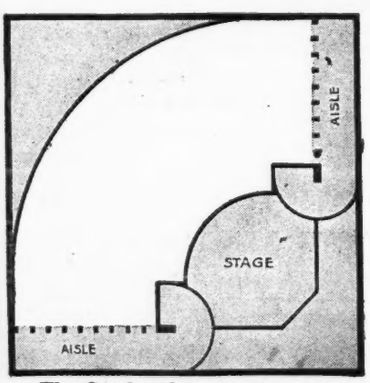


Stage Setting Painted with Light

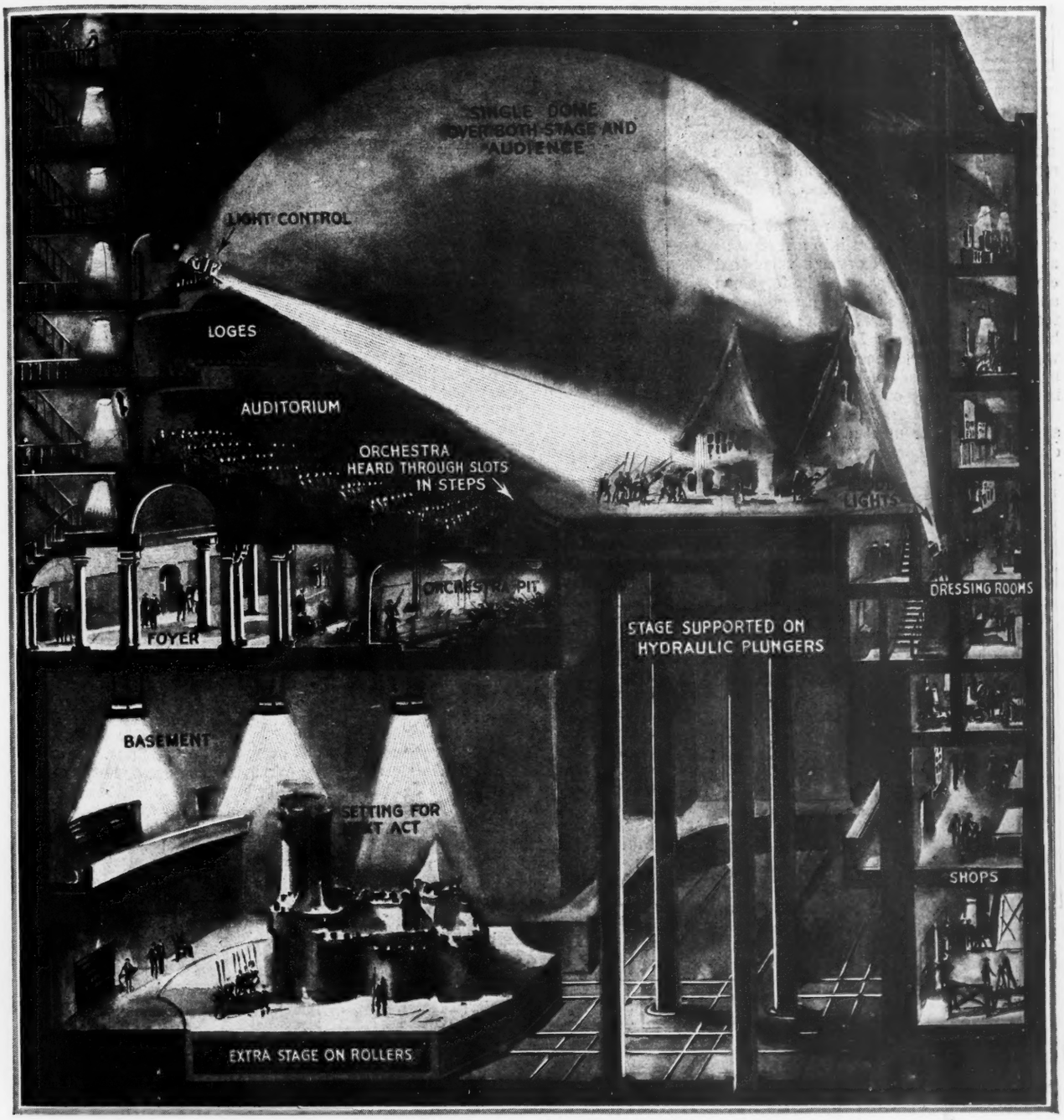
Beautiful stage effects like that from Bernard Shaw's "Back to Methuselah," shown above, are produced, not by painted back drops, but by combinations of light projected from back stage through a colored screen as shown at right



Arrangement of stage and main floor of a typical theater of today. Note position of stage on one side of the square, and the cross aisles breaking up seating space



The Geddes plan, showing corner stage and aisleless auditorium. Main floor alone seats 872 persons—50 more than main floor and balconies combined in present theater of same size



This remarkable cross section view of the theater designed by Norman Bel Geddes shows the ingenious method by which an entire stage with its settings is lowered on hydraulic plungers at the close of an act or scene, to be replaced by a new setting that is rolled onto the plungers and lifted to the auditorium for the next act.
Scenic effects are "painted" by colored lights projected from the rear of the theater

foyer extending around two sides of the theater. The remaining "underground" space between the foyer and the stage well is occupied by the orchestra, entirely concealed from the audience above. Back of the stage well are dressing rooms.

Finally, underneath this orchestra level is the basement, in which stages are rolled on and off the hydraulic lifts, scenery is kept, and various workrooms are housed.

"Painting by Light"

Especially interesting are the stage itself and its background, which consists either of a plaster dome or canvas cyclorama. Geddes supplies background partly by a quarter circle of canvas set up at the rear of the stage itself, but mostly by "painting by light."

The originators of this art conceived the idea of employing light to "paint" scenery by throwing colored lights from projection lamps on a plaster dome, or on a semicircular canvas back drop. They developed three systems of "color painting," which were introduced in America by Lee Simonson, another young American stagecraftsman.

The first of these methods—that used by Adolph Linnebach, of the Schauspielhaus in Dresden—consists of a simple lantern containing an arc light, but no lens, which throws onto the plaster or canvas background designs painted on glass. Thus, instead of painting scenes on canvas drops, as is now done, the scenery is actually painted on glass and then projected, like a stereopticon view.

The second method is that used by Max Hasait at the Dresden Opera, and adopted in New York with some success. Hasait projects a design in shadows by means of a frame, across which are fastened various thicknesses of gauze. The light that filters through one section of the gauze is of greater intensity than that projected through another section, resulting in a well-defined shadow on the plaster dome, or cyclorama. Whatever color is desired is furnished by spotlights.

Source of Light Unseen by Audience

Finally, a method called the "Ars system" includes not only remarkable projection devices for reproducing realistic cloud effects from drawings or photographs, but also a battery of high powered bulbs and lenses, by which color designs painted on glass slides may be projected, as if from a magic lantern.

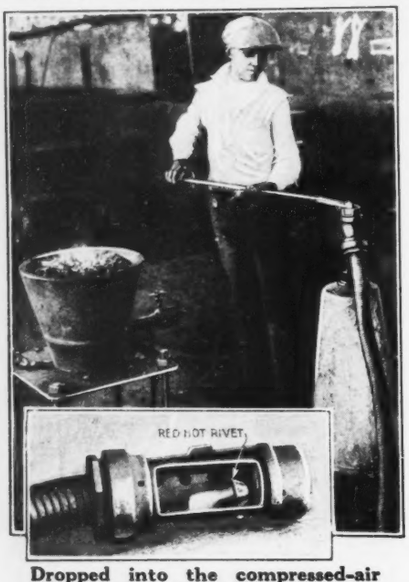
In his new theater Geddes provides for "light painting" by locating his light projector in a balcony in the back of the auditorium, out of sight of the audience.

Compressed-Air Tube Passes Red Hot Rivets

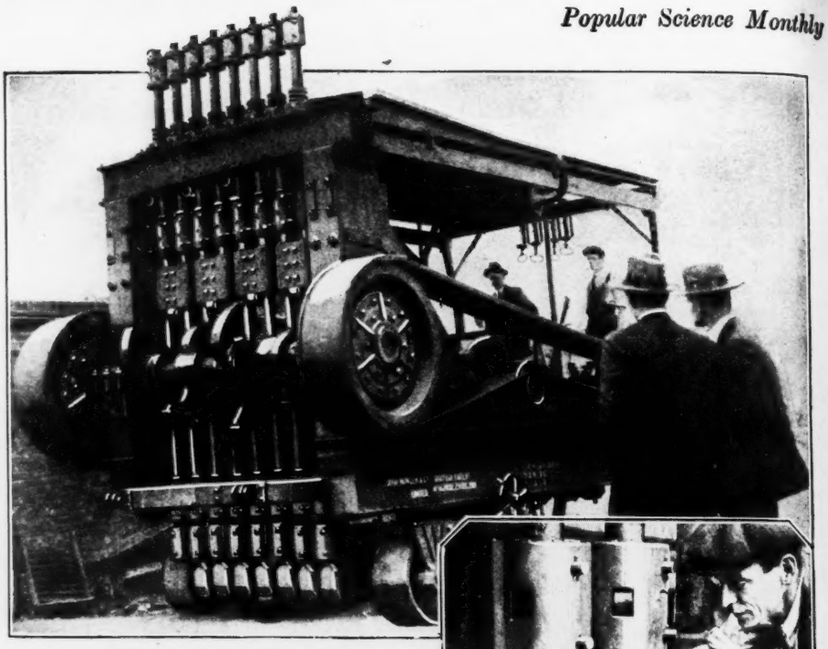
RIVET-PASSING by compressed air through a flexible metallic hose is replacing the dangerous bucket-and-tongs method. The new apparatus consists of a simple compressed-air gun and storage tank and a metal hose that leads from the forge to the riveter.

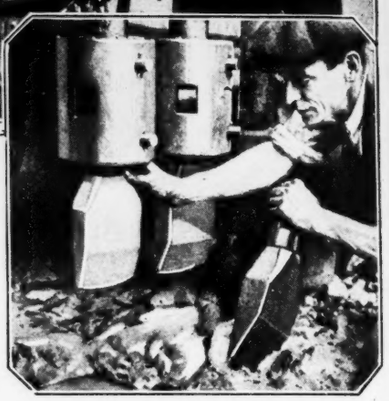
By its own weight the red hot rivet, dropped by the forgeman into a receptacle at the end of the hose, opens a valve that closes again automatically. The forgeman applies the compressed air by pressure on a foot pedal, and the rivet shoots down the hose to the job, arriving free from scale, and without possibility of accident. Rivets can be delivered 125 feet at the rate of 50 feet in three seconds by only 3½ pounds of air.

A 20 per cent saving in cost of operation, as well as greater safety, are advantages claimed for the new compressed-air method.



Dropped into the compressed-air tube, the hot rivet opens the valve





In crushing a cement road, a battery of heavy plungers, with removable chisel-shaped points, shown at right, are raised and lowered by eccentric levers on a shaft driven by the truck motor

Plunging Chisels Crush Concrete Road

THE work of battering and stripping the body of a hard concrete road—always the most difficult part of a road repairing job—has been greatly simplified by the invention of a powerful road-breaking machine mounted on a truck driven by a gasoline engine, and similar in design to the crushers once used in stamping mills to crush quartz and metal ores.

Eight heavy steel plungers, connected in couples and provided with removable wedge shaped chisel points at their lower ends, comprise the battery of crushers placed in a row at the front end of the truck. These plungers slide in bearings and are alternately lifted and dropped by four eccentric levers keyed to a rotating shaft driven by the truck engine. The weight of the plungers is so great that, as they drop from a height of about two feet, their sharp chisel points cut through the concrete and break it into fragments.

Two heavy flywheels provide for continuity of the reciprocating motion of the plungers. The machine weighs about two tons.

Whenever one of the chisel points becomes worn or broken, it is quickly replaced by another.

Four Thousand Miles in a Rowboat

IN A 16-foot combination power and row boat driven by a single cylinder, 2½-horsepower engine, Walter P. Horger and Henry J. Miller started from Detroit, Mich., recently on a 4000-mile cruise through the Great Lakes as far as Duluth, Minn., and back.

Their route was through the center of Lake St. Clair, along the American shore of Lake Huron, across the middle of Saginaw Bay, through the straits of Mackinaw and St. Mary's River to Lake Superior, and finally along the Wisconsin and Minnesota shores to Duluth.

Under ordinary weather conditions and in smooth water the boat is capable of making from seven to eight miles an hour. It is equipped with a canvas top with two holes through which the adventurers can stick their heads. This top keeps out water during heavy seas.

The map above shows the 4000-mile route of Horger and Miller in their cruise through the Great Lakes from Detroit to Duluth and back in a 16-foot power and row boat

House Numbers on Curbs

PAINTING house numbers on the curb where they are in plain sight of automobilists and drivers of delivery cars, is a practice that is becoming popular with residents of Glendale, Calif.

The numbers are stenciled on the curb with lampblack and oil and will last for years. Before the stenciling, the curb is cleaned with a stiff steel brush. The numbers used are about six inches high. The cost of stenciling the complete number is only 25 cents, yet the saving of time to merchants in making deliveries is said to amount to thousands of dollars a year.

Six-Story Foundation for Apartment House to Hold Garage

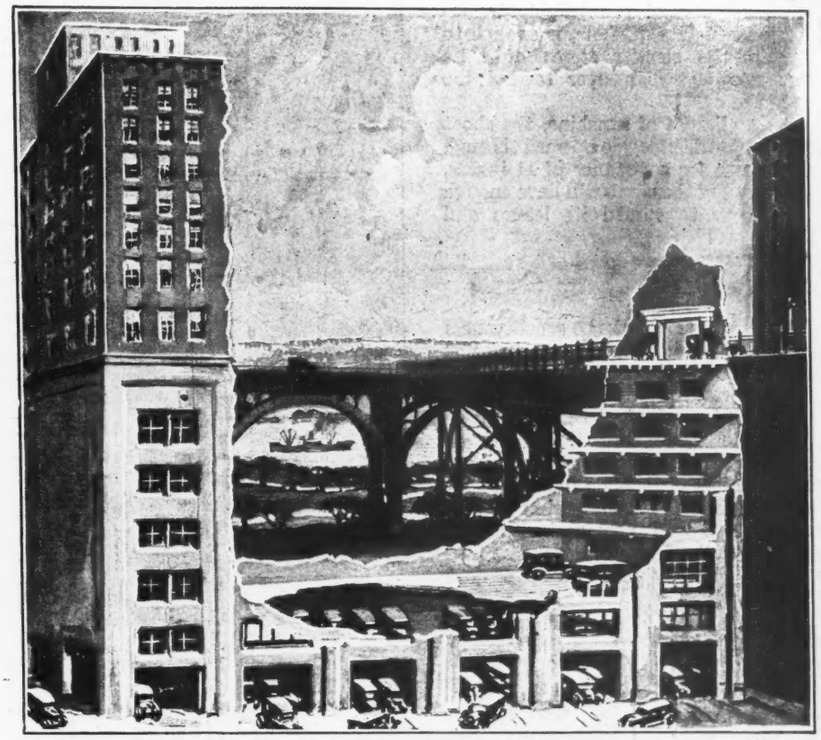
APARTMENT houses with entrances at the sixth floor, 80 feet above the ground, will soon be constructed in the fashionable Riverside Drive district of New York City to face an elevated cross street that bridges a deep valley and joins the elevated drive at 134th Street.

Since residences on Riverside Drive and on cross streets leading from it command high rents, builders quickly seized the opportunity offered by the opening of the elevated street. They found it impracticable, however, to build residences from the ground to the 80-foot level of the street. On the other hand, the cost of building a foundation 80 feet high would be tremendous.

How the Problem Was Solved

They are solving the problem by designing an extraordinary type of apartment building in which the lower half, from the ground level to the sixth floor entrance, will inclose garages and warehouses. Upon this foundation building will be erected the eight-story modern apartment house proper.

All the buildings facing Riverside Drive and the cross street to a distance of 200 feet from the intersection of the elevated streets will be of this type.



Cutaway view of proposed apartment house showing garages in foundation

How to Measure Your Body's Horsepower

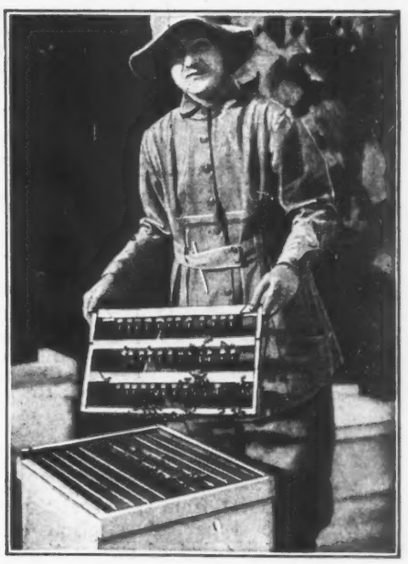
DO YOU know how strong you are? Run up the stairs as fast as you can—two or three at a time if you like—and have some one note the time in seconds you require to climb a definite height in feet. From these figures, and your weight, including clothes, you can determine your "horsepower" by means of the chart shown below the accompanying illustration.

Suppose you weigh 150 pounds and climb the stairs at 60 vertical feet a minute. On the upper scale, *A*, find 150 and 60, and take the point halfway between, or 105. On scale *B* is your horsepower—about 0.273.

By hauling up a weight with a rope passing over a pulley, you can find the horsepower of your arms, using the table.

Weigh yourself, then run upstairs as fast as you can to a definite height, while small brother times you in seconds

On scale A find numbers corresponding to your weight and your speed in feet to the minute. Halfway between read your horsepower on the scale



Successful Woman Beekeeper Invents Queen Incubator

FINDING millinery less profitable and less interesting than beekeeping, Miss Josephine Whipple, of Los Angeles, Calif., turned professional apiculturess and has recently invented a queen bee capsule, or incubator, in which the queen bee spends the first ten days of her life. It is declared to be a valuable contribution to apiculture.

On the queen bee depends the entire life of the bee colony. She lays the eggs, in cells provided by the workers, and these eggs later hatch into other queens. Queen rearing has become a distinct industry in the United States, with a large export trade.

Miss Whipple's earnings in one year are said to be as high as $12,000. The profits from the industry may be realized from a recent transaction in which half interest in a prize queen was sold for $150.

How Plants Bend and Struggle to Reach Light

FIVE minutes of candlelight, streaming through a pinhole, is enough to make the slender stems of little mustard seedlings lean over toward the source of the light!

To get a glimpse of sunshine, the shoot of a tulip bulb will struggle upward through the dark earth for a distance of 11 inches, and at the end of the climb will have enough reserve energy to spread its leaves and create a flower!

These remarkable photographs show the tremendous growing power of tulip bulbs seeking the light, and the growth of their plants when the bulbs were planted at depths of six inches, 11 inches, 12½ inches, and 14 inches (left to right)

Light, Not Heat, Causes Growth

Interesting facts about the sensitiveness of plants to light and the energy they put forth under its influence have been revealed in a series of experiments, conducted by scientists of the United States Department of Agriculture during the past year, that have revolutionized our knowledge concerning the effect of light on plant growth. The work of Uncle Sam's experimenters in discovering a brand new agriculture in which the growth of plants is governed by light rather than by heat was described fully by Lewis E. Theiss in an article in the December issue of POPULAR SCIENCE MONTHLY.

The new experiments with tulip bulbs, incidentally demonstrating the tremendous growing power of the bulb in response to light, are illustrated at the top of this page. When a bulb was covered with six inches of soil, its shoot easily reached the surface and developed healthy foliage and flower. When the soil covering was increased to 11 inches, the bulb had sufficient energy to send its shoot to the surface, expand leaves, and create a fairly perfect flower, although the portion of plant above the ground level was comparatively small.

And even when the covering was increased to 12½ inches, the plant from the bulb managed to struggle to the surface, even though its flower was unable to make the grade, and remained within 1½ inches of the top until it shriveled.

The experiment that revealed the extreme sensitiveness of mustard seedlings to light. Covered by a box into which candlelight was allowed to filter through a pinhole, the seedlings after five minutes were found to be leaning toward the source of light, as shown at the right

Plant Makes a Brave Fight

Covered under 14 inches of earth, the bulb shot up its plant 13 inches and then abandoned the struggle.

In the experiment revealing the sensitiveness of mustard seedlings to light, the seedlings were covered by a box with a pinhole in the center of one side. After this hole had been uncovered for five minutes to admit the light of an ordinary candle, the little plants were found leaning over in the direction from which the light came.

Further interesting experiments were made by Dr. R. B. Harvey, of the University of Minnesota. By illumination from tungsten filament nitrogen-filled lamps he ripened many varieties of seeds in unheated basement rooms, where no sunlight entered.

Wing Spars Support Engine of New Loening Monoplane Racer

DEPARTING from the usual "automobile type" of airplane construction—that of supporting the engine, with propeller, on the longerons or longitudinal members of the fuselage, Grover C. Loening, famous young American airplane inventor and designer, has perfected an extraordinary type of racing monoplane in which the wings and the powerful engine they support form a complete flying unit in themselves.

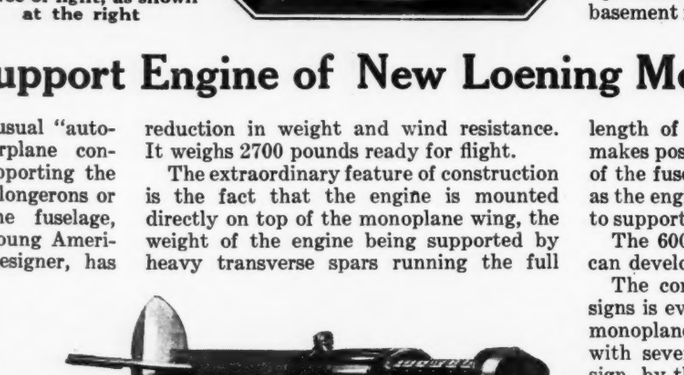
Loening has added just enough length of featherweight fuselage to provide for the pilot's cockpit and the tail surfaces.

The new machine, said to be the most powerful for its size in the world and able to attain a speed of 200 miles an hour, was entered in the recent Pulitzer Trophy race at Detroit, Mich. One of its chief advantages is said to be reduction in weight and wind resistance. It weighs 2700 pounds ready for flight.

The extraordinary feature of construction is the fact that the engine is mounted directly on top of the monoplane wing, the weight of the engine being supported by heavy transverse spars running the full length of the main wing structure. This makes possible extremely light construction of the fuselage, which is only twice as long as the engine and is built just heavy enough to support the pilot and tail surfaces.

The 600-horsepower, 12-cylinder engine can develop 630 revolutions a minute.

The continued success of Loening's designs is evidenced by the fact that his fast monoplane air yachts have been adopted, with several minor improvements in design, by the Army Air Service.



The powerful new Loening racing monoplane, showing how the engine is supported by the heavy braced monoplane wings. Note the comparatively short length of the light fuselage

Tanks Waste Fuel

A TON of coal a year is wasted by each uninsulated hot-water tank in use in American homes, according to the statement of a prominent manufacturer. Four fifths of this loss is preventable, and greater economy is possible if all hot water and hot air pipes are insulated.

Automatic Speed Control Brakes Train at Curves

DESIGNED to prevent disastrous train wrecks due to the failure of engineers to observe block signals or their carelessness in taking curves at excessive speed, an automatic train governor, designed by E. Rodolausse, a French engineer, not only makes a train foolproof, but actually keeps an accurate record of a train's performance by which the engineer's competency can be judged.

Control Keeps Tab on Train

Here are a few of the things that the governor does automatically:

Stops a train the instant the locomotive passes a block signal.

Brakes a train when its speed in taking a curve passes a certain specified limit.

Makes a permanent speed and braking record, showing every action of the train on an entire trip.

The automatic control mechanism, contained in a small box attached to the locomotive tender, is propelled by a shaft from the foremost tender wheel, and is set to a specified maximum speed by means of a dial on the outside of the box. When the speed of the train, transmitted to the control mechanism through the shaft, passes the specified maximum, a centrifugal governor automatically opens a safety valve that applies the brakes until the speed of the train falls below the maximum limit.

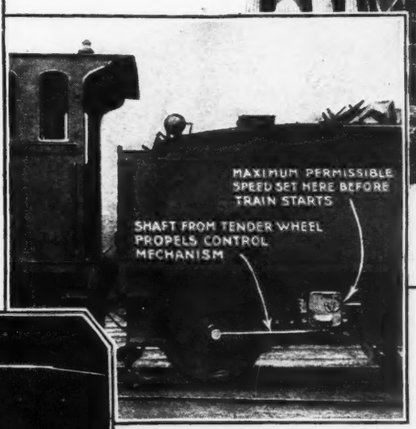
At the front end of the locomotive is a chain fender adjusted to strike vertical rods placed along the railway line at approaches to dangerous curves, or wherever tracks or switches are not clear. The impact of one of these rods on the chain, as the locomotive passes, is transmitted to a solenoid in the control box. This solenoid operates a cam wheel that opens a safety valve and sets the brakes.

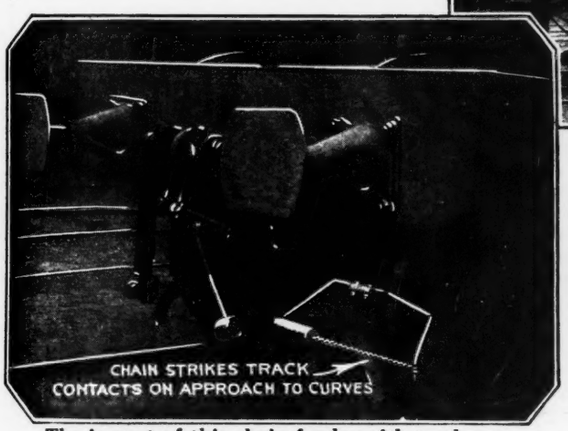
Meanwhile, every operation of speed regulating and braking is recorded on a paper strip.

This Train Passed a Block Signal

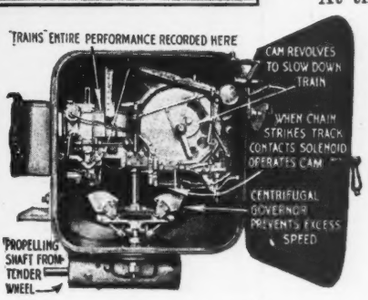
Caused by the failure of an engineer to heed a block signal, this disastrous rear-end collision near Sulphur Springs, Mo., in which 35 persons were killed and more than 100 injured, might have been prevented by the automatic control shown below

© International





The impact of this chain fender with track contacts on approaches to curves sets the brakes


TRAINS ENTIRE PERFORMANCE RECORDED HERE
CAM REVOLVES TO SLOW DOWN TRAIN
WHEN CHAIN STRIKES TRACK CONTACTS SOLENOID OPERATES CAM
CENTRIFUGAL GOVERNOR PREVENTS EXCESS SPEED
PROPELLING SHAFT FROM TENDER WHEEL

Inside control box, showing speed and brake adjustments

This Raft-Boat Sails against the Wind by Wind Power!

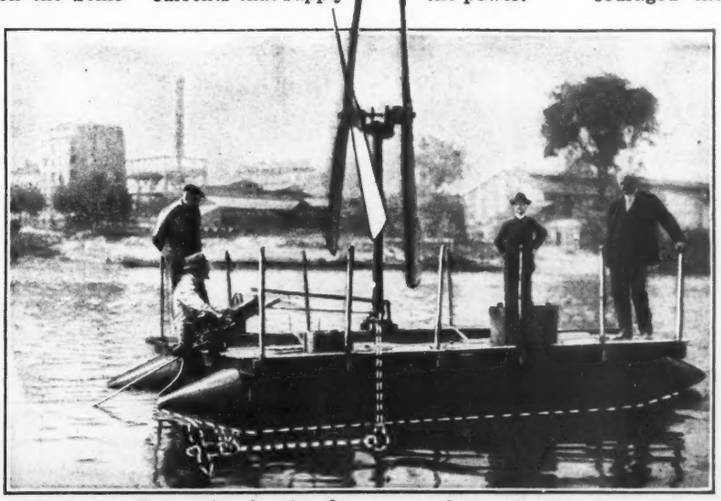
DRIVEN by the power of the wind, yet able to progress against the wind at moderate speed, a small water craft of unique design recently made several successful trial trips on the Seine River, near Paris, navigated by the inventors.

The apparent paradox of sailing against the wind by wind power is explained as follows:

Saving Energy

The wind turns large vanes like those of a windmill and the energy thus generated is transmitted by a belt and pulley to a shaft, the submerged end of which carries a propeller. As the blades of the submerged propeller press against a much heavier and more substantial medium than the air propeller, the slippage is much smaller. The saving of energy resulting from lesser slippage and greater speed of revolution makes it possible for the craft to move contrary to the direction of the very air currents that supply the power.

The inventors have built several models on a small scale, the largest of which is a raftlike craft of three tons, about 18 feet long. The success of the trials has encouraged the inventors to undertake the construction of a five-ton craft of the same type.



Wind propelled craft, showing how vanes drive submerged propeller

Home Humidifiers

THE necessity for increasing the humidity of the air we breathe in our heated homes, if we would prevent wintertime sickness, was pointed out in the December POPULAR SCIENCE MONTHLY.

Growing recognition of this has induced builders of some of the finest homes in America to equip them with air humidifying apparatus. A manufacturer specializing in such devices reports recent installations in new homes in many cities.

Where the Bottom Fell Out of the Sky

Eye-Witness Describes Colossal Cloudburst in a Western Canyon

By John Edwin Hogg

I HAVE just talked with the only eye-witness of the most colossal cloudburst recorded in modern times—with Joe Lacy, a guardian of the Los Angeles water supply aqueduct, whose family fled up the hills from their doomed cabin on the edge of the Mojave Desert, Calif., while a wall of water 60 feet high thundered down the canyon at their heels.

This phenomenal deluge occurred a few months ago, over a region of four square miles, within the watershed of Sand Canyon, a gorge descending from the Sierra Nevada Mountains in southern California.

A Twelve-Foot Sheet of Water

Within the space of half an hour it is estimated that 240 inches of rain fell on this small area. Imagine this in a region where two inches of rain in 24 hours is considered a record! Imagine what such a cloudburst would have meant if it had burst over a big city, sending a sheet of water 12 feet thick crashing down upon the homes and streets, wrecking buildings and perhaps drowning thousands.

Even in this mountainous desert region where, through a queer freak of weather conditions, it actually did occur, the cloudburst wrought appalling devastation. It smashed to pieces the only substantial dwelling in the region, carrying a 640-acre pasture bodily down to the desert, and leaving only a great, mud-filled gorge where the homestead had been. Its waters swept more than 30 feet deep over the Los Angeles aqueduct, which crosses the canyon's mouth. They uprooted huge trees that had been growing for 250 years, and left them nothing but battered logs buried in silt, miles out on the desert floor.

An incalculable quantity of earth was picked up in the flood's nine-mile rush down the canyon, and deposited for miles out in the desert, from two to 20 feet thick, in a tremendous, fan-shaped mass, with a front 15 miles wide.

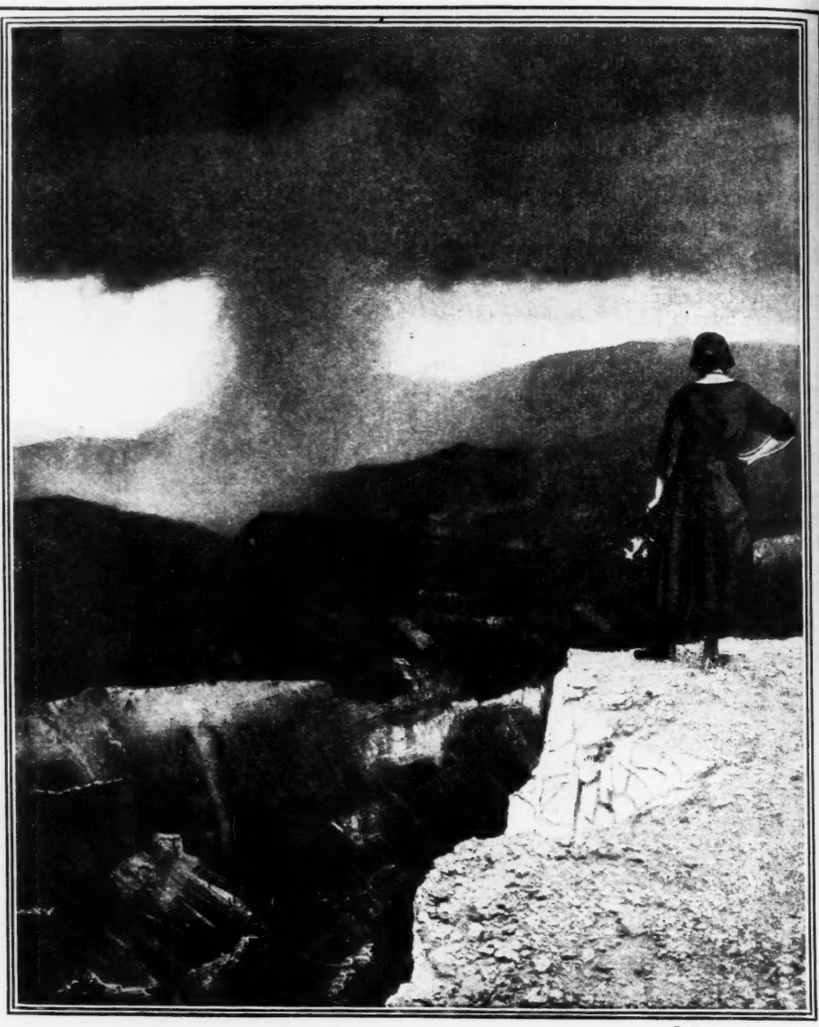
The mud deluge buried the motor road, blocked traffic for several days in the valley, and wiped out some 10 miles of the Southern Pacific's tracks.

Lacy's story of the downpour is dramatic.

Story of Eye-Witness

"It was about nine o'clock in the evening," he told me, "when I heard violent crashes of thunder in the mountains. Then came a roaring, rumbling, crashing noise that sounded like an army of motor trucks coming down the canyon. It dawned on me that the noise was caused by a mighty wall of water rushing down from the mountains above—a deluge that I could see at intervals as the lightning flashed. I could see trees and boulders being flung high as if by huge explosions of dynamite, and come thundering down the gorge."

Lacy had observed the storm gathering over the mountains all day. Early in the afternoon, he saw two thunderstorms gathering. Over the highest hills, near the head of Sand Canyon, were great banks of clouds that appeared to be rushing toward the mountains—and this struck him as extremely unusual, since most of the desert storms come from the mountains to the west.



© Ewing Galloway

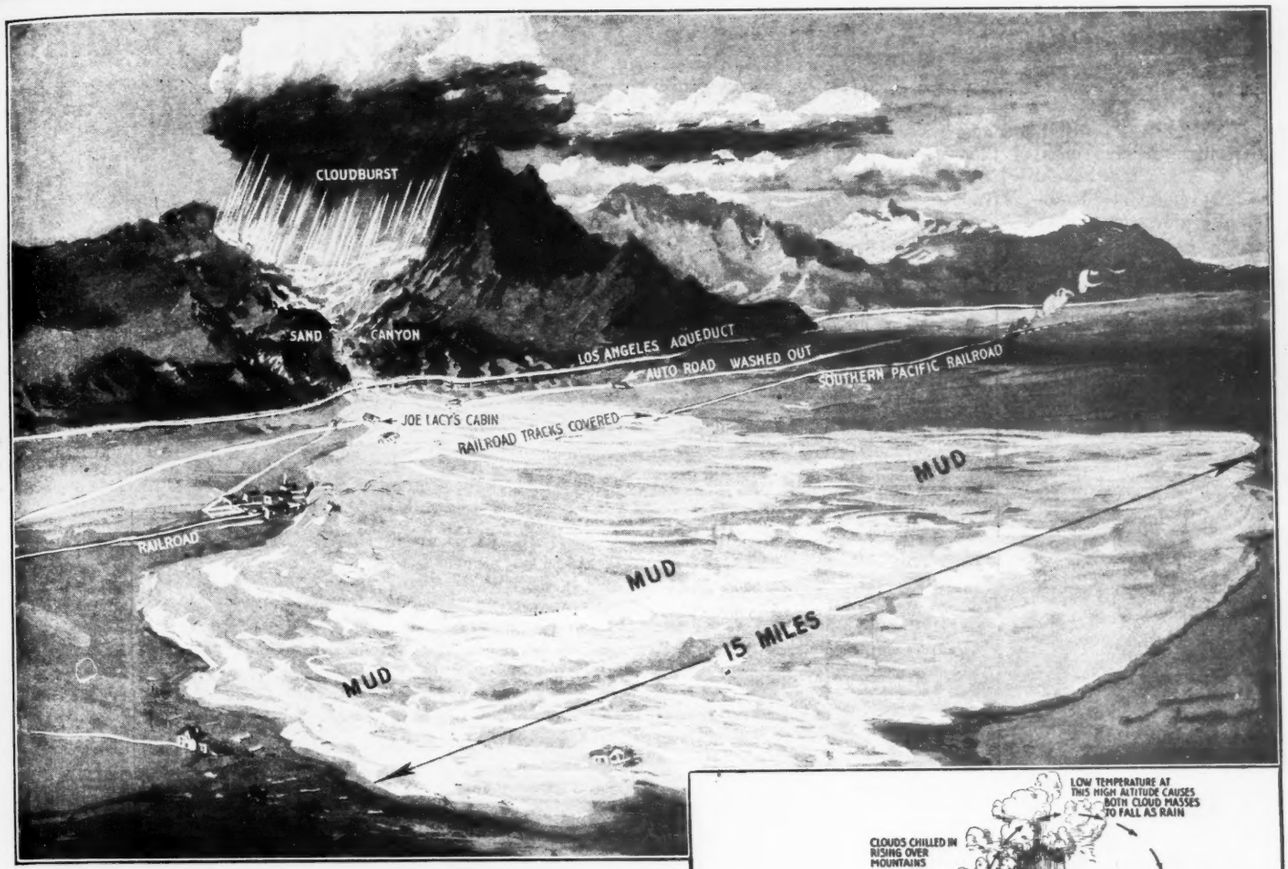
This extraordinary photograph of a mountain cloudburst, taken at the rim of the great Colorado River canyon in southern Utah, shows in the distance a dark deluge emptied by storm clouds in their passage over the mountains

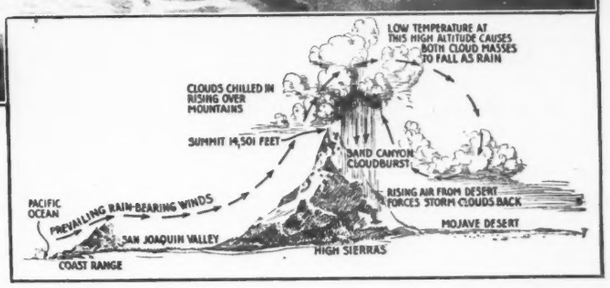
On the floor of the Mojave Desert, 12 miles from the mouth of Sand Canyon, was found this battered tree trunk—the remains of a lofty pine torn from the canyon walls and carried 23 miles

Safety in the Hills

"After I realized what was happening," he continued, "I rushed into the house, shouted to my wife and children to run for the hills, and grabbed a telephone—a private line connecting me with the Los Angeles Water Department. I shouted to the engineer at the other end: 'Sand Canyon is about to be washed off the face of the earth! Send your engineers and workmen, for the city soon will be cut off from water!'

"Then the line broke, and I rushed to the safety my family had found in the mountains above. From there I watched by lightning flashes the water sweep everything before it, including our home.




LOW TEMPERATURE AT THIS HIGH ALTITUDE CAUSES BOTH CLOUD MASSES TO FALL AS RAIN
CLOUDS CHILLED IN RISING OVER MOUNTAINS
SUMMIT 14,501 FEET
SAND CANYON CLOUDBURST
RISING AIR FROM DESERT FORCES STORM CLOUDS BACK
PACIFIC OCEAN
PREVAILING RAIN-BEARING WINDS
MOJAVE DESERT
SAN JOAQUIN VALLEY
HIGH SIERRAS
COAST RANGE

THIS bird's-eye view shows the vast sea of mud picked up in the flood's nine-mile rush down the canyon and deposited on the Mojave Desert in a fan-shaped mass 20 feet thick in spots and 15 miles wide. At the mouth of the canyon are shown the Los Angeles water supply aqueduct that withstood the deluge, and the cabin from which Joe Lacy, aqueduct guard, escaped with his family. The diagrammatic sketch at the right illustrates the scientific explanation of the cloudburst

"My first concern, of course, was for the pipe siphon of the aqueduct that crossed the head of the canyon, for I knew that if it were destroyed, Los Angeles would be cut off from its water supply. Going down the mountainside, as soon as I was certain that the water was not creeping any higher, I found that the top of the huge pipe, 26 feet above the floor of the canyon, was covered with water to a depth of more than seven feet!

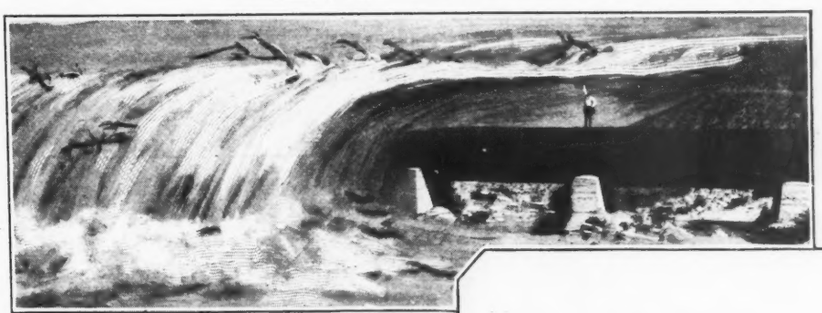
"Although battered, the aqueduct was safe. At midnight the water was going out of the canyon at the rate of 2500 cubic feet a second."

From the marks of the flood it is evident that the water in some places attained a height of 65 or 70 feet, while it splattered mud a full 100 feet above the canyon floor.

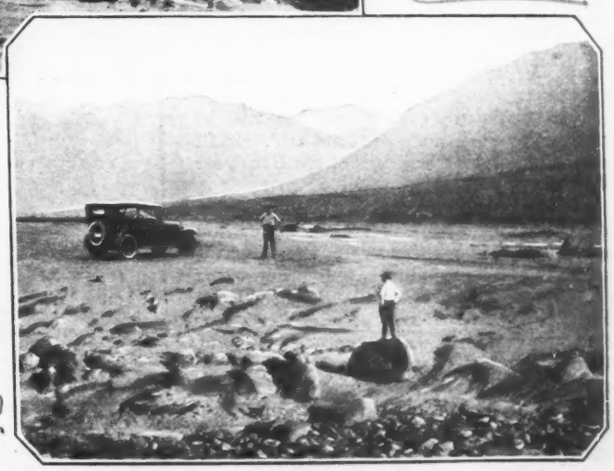
The reasons for the freak storm were:

Over the west slope of the Sierras, the prevailing rain-bearing winds blow from the Pacific Ocean. To get over these lofty peaks, the clouds are driven to a very high elevation, where they are chilled by the atmosphere, causing the moisture in them to be precipitated in the form of rain.

On this day, there evidently was an unusual meteorological condition that caused a swirl or whirlpool of air currents over the top of Sand Canyon. This wind eddy lasted all day, gathering clouds from the entire mountain range, and shaping them into a cloud vortex over the canyon. A thunderstorm that had previously passed over the mountains into the Mojave Desert was sucked back into the mass, and a second storm met the first one in the small whirlpool of air; the clouds were pushed upward to a tremendous elevation and became instantly chilled, changed into moisture, and poured down in the form of rain. Unquestionably, both storms were of unusual size. Either one of them in itself would have caused an extraordinary cloudburst. Combined, they dumped more water in 30 minutes onto this small region than would be contained in the entire normal rainfall for eight years.



The enormity of the flood that swept over the Los Angeles aqueduct at the mouth of Sand Canyon is shown in the photo-diagram above. The man on top of the great pipe has raised his arm to indicate the height reached by the waters



At right: The Mojave Desert with the mouth of Sand Canyon in distance, showing portion of the deep deposit of mud and boulders carried down from the mountains by cloudburst

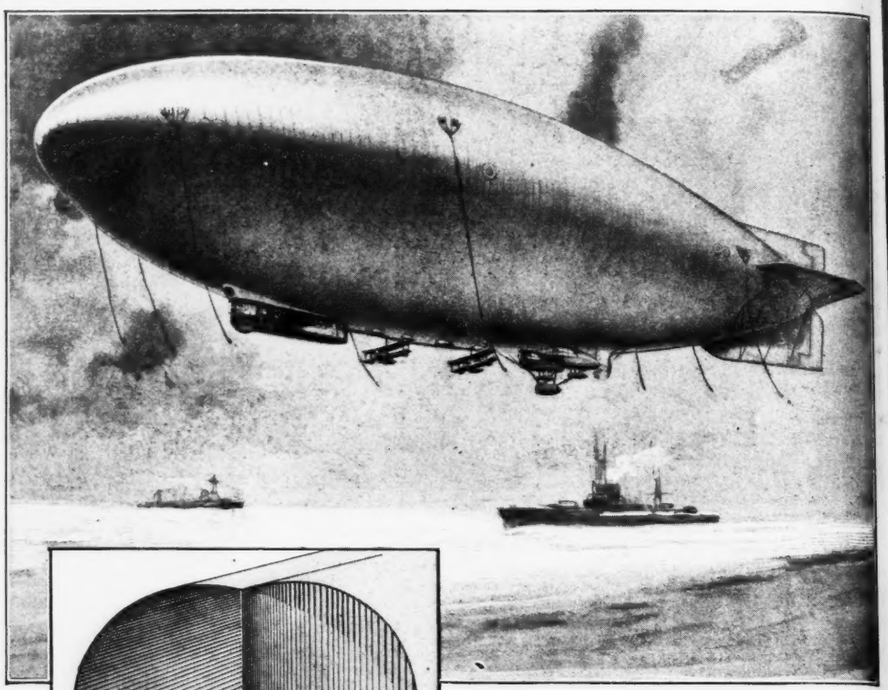
First "Mother Ship" for Airplanes to Use Helium

By James M. Scott

UNCLE SAM will soon own the first "mother ship of the air." Carrying beneath her huge 300-foot body a brood of speedy bombing and scouting planes that she can release or pick up while traveling at full speed, the "R-1"—first semi-rigid airship to be built in America—will provide, when completed, an effective means of patrolling the Atlantic or Pacific seaboard.

Herman T. Kraft

Chief aero engineer of the Goodyear Tire and Rubber Company, in charge of constructing the "R-1." He predicts that "the entire surface of the airship of the future will be of metal. And the first practical all metal airship will open wide the gates to the use of the airship commercially"



The 300-foot semi-rigid army airship "R-1" as she will appear when completed, with scout planes suspended from her rigid keel as explained below, and with navigation car forward and two power cars aft, side by side

Cross section of the semi-rigid "R-1," showing double envelope that will inclose helium filled balloonets, and rigid, three-cornered framework keel of duralumin that will run the entire length of the ship

Construction of this remarkable "mother airship" for the United States War Department will begin at an early date at the plant of the Goodyear Tire and Rubber Company at Akron, Ohio. And the most significant feature about her—especially from the standpoint of commercial development—is that she will be the first airship to be designed and built especially for the use of non-inflammable, helium gas.

Indeed, Dr. R. B. Moore, chief chemist of the United States Bureau of Mines, in charge of the government research work in connection with helium, declares that the future of lighter than air craft never has been brighter than it is today, and that the problems of helium production have been solved. Within the next decade, he adds, 99.9 per cent helium will be produced at a cost as low as $20 the cubic foot.

A Rigid, Triangular Backbone

The work of constructing her will be under the direction of Herman T. Kraft, chief aeronautical engineer of the Goodyear Company.

The ship's structural rigidity will be along its backbone, which will consist chiefly of a duralumin framework keel of triangular cross section running from nose to tail. Into this keel will be built the large frame of the nose cone and also the fins, forming one integral structure. It will be driven by four low compression Liberty motors. Three cars, constructed of duralumin and aluminum, will be slung from the keel, the navigation car being forward and the two power cars aft, side by side.

The pilot's car will ordinarily carry a crew of from 16 to 20 men. A telautographic signaling system, by which the pilot can signal the power cars for speed changes, engaging motors, and reversing, will be a feature of the control-board equipment. The propellers will be 20 feet in length and will have 640 revolutions a minute.

Small Electric Motor Shakes Sifter

This sifter is shaken by an electric motor beneath the screen

A NEW electric sifter, which shakes material through a screen at an extraordinarily rapid rate, has a novel eccentric that produces a rapid shaking motion.

The material to be sifted is thrown into a container at the top of the sifter and falls upon a movable mesh screen. A small electric motor beneath the sifter rotates a shaft connected with the screen through an eccentric, imparting a vibratory motion to the screen and causing the small material to be brought over the openings in the middle.

The machine is capable of screening a ton of moist sand in four minutes. It is also used for the purpose of separating the solids from the liquids in various processes used in chemical manufacturing industries.

You Can Make Your Home Safe from Fire

Walls of Metal Lath and Plaster Withstand Blaze for an Hour

WILL you be one of the 15,000 victims of fires in the United States this year?

Will your home be one of the 1600 dwellings offered as unwilling sacrifices to the God of Flames this week?

You can't answer those questions. But, thanks to remarkable progress in the science of fire prevention and fire control, you *can* help to cut down the $1,500,000 daily toll exacted by preventable fires in this country, and of which you now must pay your share. You can help to reduce the tremendous cost of fires in human lives sacrificed. And the way you can do it is to observe a few simple precautions to safeguard your own life, the lives of your family, and your home.

Homes Protected at Small Cost

By the most authoritative and complete fire tests ever attempted, the Fire Underwriters' Laboratories of Chicago, Ill., have proved that we can make the ordinary frame dwelling almost completely fireproof. Obviously, we cannot reconstruct the homes in which we now live, but we can make certain simple, inexpensive improvements that will make them far more fireproof than they are now. And if we are building new homes, we are assured that fireproof construction will not entail additional cost.

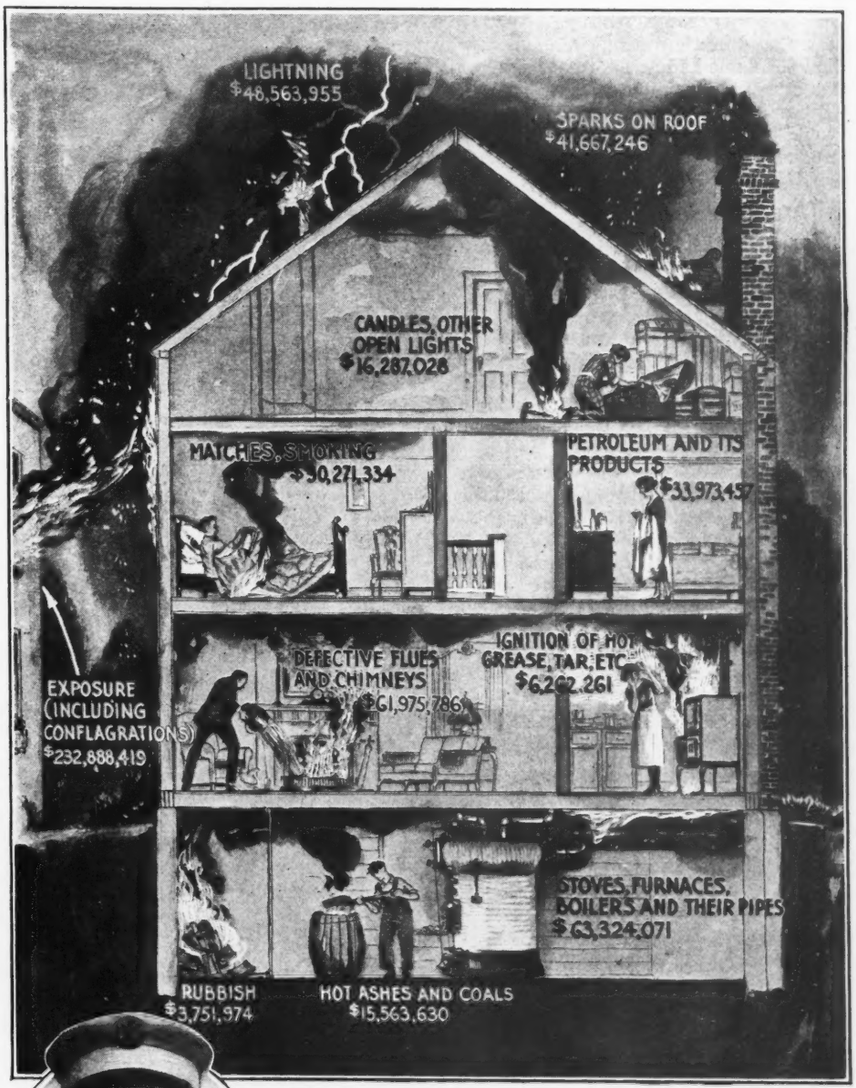
Fire is the world's greatest peace menace. The United States spends yearly $283,000,000 (nearly enough to build a Panama Canal) to replace fire losses. And a very large percentage of this loss results from fires in homes. The problem of confining fires to the buildings in which they start has been practically solved as the result of careful education in building, increased vigilance and efficiency of fire departments, and modern fire fighting methods. The important problem now is that of confining fires to the *rooms* in which they start. This may be accomplished, experts tell us, only by thorough education to eliminate common acts of carelessness, use of materials advised by those who make it their business to examine fire risks, and actual replacement of hazardous parts of our homes.

New Fireproof Building Material

In response to a growing demand, engineers now have developed a fireproof material for home construction that, in exhaustive tests, has proved to be an entirely adequate safeguard. This material consists of plaster of Paris (or gypsum) and expanded metal sheeting or lath. Several coats of the gypsum plaster are applied after the sheeting is nailed to the studding in the same way that laths are now put up. The sheeting tested and approved is three-eighths-inch diamond mesh such as is now used for stucco work on the outside of houses. It serves to support the first, or "scratch," coat of gypsum and sand mixed in the ratio of one to one. The second or "brown" coat consists of fibered or sanded gypsum in a ratio of one part gypsum and two parts fine sharp sand. The third, or finishing coat, is a mixture of three parts lime putty to one part dry calcined or burned plaster.

Neither the materials nor the method of application are patented, and a wall or ceiling can be constructed by any plasterer at a cost no greater than that of ordinary plaster or cement. The metal is manufactured by steel companies for other purposes or expressly for use in fireproofing homes. The plaster of Paris is derived from gypsum, a common mineral, by a process of heating that removes the water contained in the mineral. It can be obtained and applied by any builder.

In the tests performed by the Under-



The most common causes of preventable fires that destroy 1600 dwellings every week in the United States and the consequent loss in dollars over a period of five years are indicated above

Fire Buff Gives Advice on Fire Prevention

ONE of the queerest hobbies in the world is that of Robert H. Mainzer (at left), a Wall Street broker whose lifelong avocation has been attending every big fire in the city.

More than a score of prominent New Yorkers have the same fad. They race off to fires with the enthusiasm of schoolboys, and the name of "fire buff" was invented to describe them.

But Mainzer is the champion "fire buff" of them all. He has in his home a special fire alarm apparatus. When a big blaze breaks out, he drops everything to rush to the scene, and he works as hard as any of the firemen there. Having seen 4353 three-alarm fires, and inspected fire departments in most of the world's greatest cities, Mainzer speaks with intimate knowledge of fire prevention problems. He says:

"Carelessness, inadequate construction, and incendiarism, are the three chief causes of fires. Innumerable fires from the first two causes could be prevented, if we took simple precautions. The fire peril is so grave in the nation today that every person should give thought to it, and teach fire prevention methods to his children."

writers' Laboratories the material was in the form of a ceiling and a wall. For the wall test, a double wall was constructed consisting of two by four inch studding spaced 16 inches apart. Upon these was nailed the metal sheeting. Gypsum plaster was then applied to both sides of the wall and the entire 10 foot by 12 foot frame was placed in a gas furnace in such a way that the flame had access to one side, while the other side was unexposed. Thus conditions similar to those to which a wall would be subjected in an intense fire were produced and the results were analyzed.

A Barrier to the Flames

When one of the slabs thus tested was exposed to the flame for 4¼ hours, the thermometers on the unexposed side of the wall registered an average of 263° F., while the temperature of the side exposed to the flames averaged 2030° F.

A second slab was subjected to both fire and water, the flames beating upon one side for an hour, after which the slab was withdrawn and subjected to the force of a 1⅛-inch stream of water. The wall was practically destroyed, of course, yet not until it had withstood the extreme onslaughts of fire and water for an hour.

This "time rating" of one hour was far greater than any rating ever given to walls constructed of other materials.

The ceiling test was performed by constructing a ceiling of these materials over a furnace and loading the ceiling with bricks to imitate the conditions that actually exist when a ceiling bears the load of a floor above. The "time rating" again was extremely high, although, as in the wall test, the ceiling was eventually destroyed.

A section of rigid metal lath nailed to studding as reinforcement for plaster or stucco is effective fireproof construction of walls or ceilings

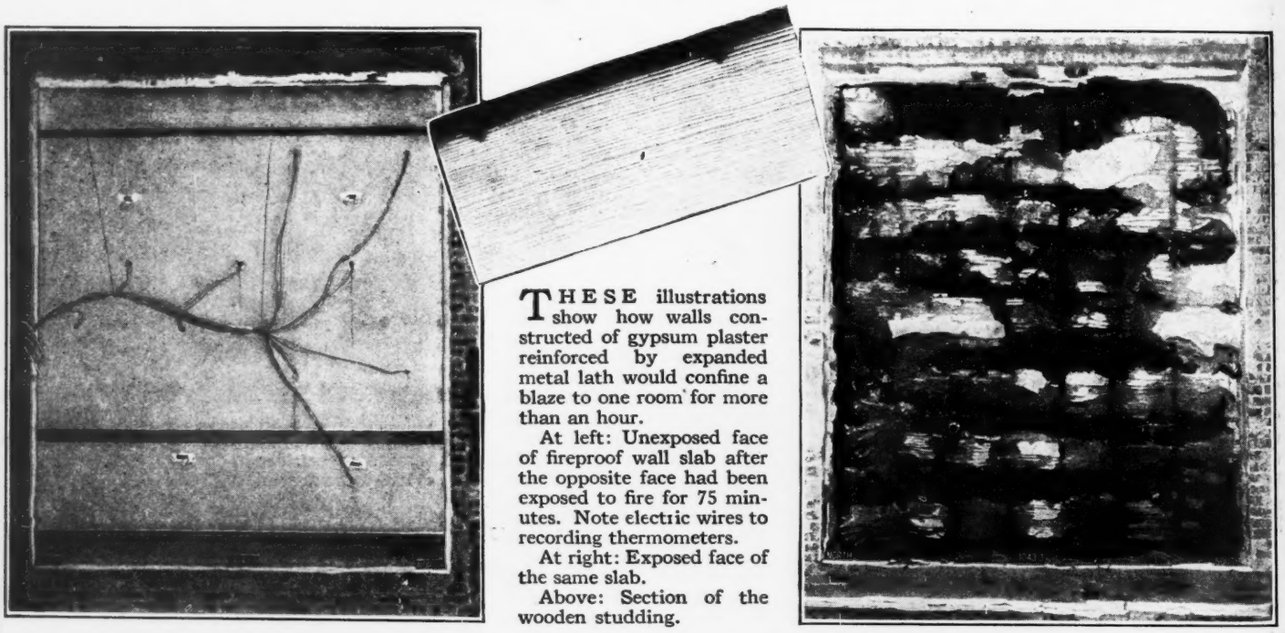
By these terrific fire tests the experimenters effectively demonstrated that if a fire should gain headway in one of the rooms of a home inclosed by fireproof walls built of the materials tested, the blaze could be confined to that room for more than an hour without danger of its spreading to other parts of the building.

Where Metal Lath Gives Safety

By slight alterations, vulnerable parts of our homes may be made fireproof with these materials. Metal lath can be used over the furnaces, in closets, around flues, staircases, bearing partitions, and the inhabited floors at a cost less than the interest charge for four months' occupancy—and give safety nearly equal to that assured by complete fireproof construction.

In addition, all of us should see that our homes are roofed with incombustible materials. We should safeguard floorings where steam pipes pass through by fitting metal collars on the pipes, place asbestos boards above furnace pipes that are too close to beams, and see that all electrical circuits are installed in approved conduits.

Finally, we must guard against carelessness, which is the greatest cause of fires, by disposing of matches, cigarette and cigar butts in metal receptacles, keeping our basements clear of rubbish, using metal containers for ashes, using non-inflammable materials for cleaning purposes, and properly protecting our homes with lightning rods. These precautions will assure safety.



THESE illustrations show how walls constructed of gypsum plaster reinforced by expanded metal lath would confine a blaze to one room for more than an hour.

At left: Unexposed face of fireproof wall slab after the opposite face had been exposed to fire for 75 minutes. Note electric wires to recording thermometers.

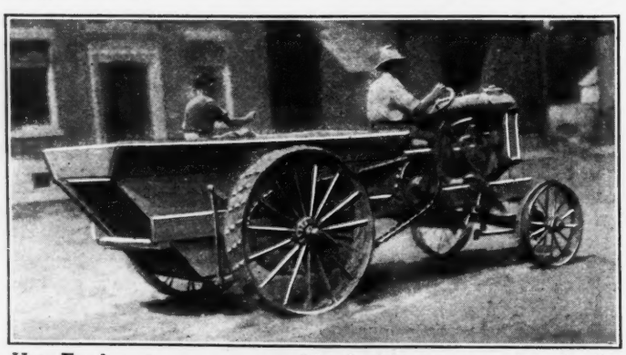
At right: Exposed face of the same slab.

Above: Section of the wooden studding.

This Large Capacity Truck Was Built from a Tractor

CONSTRUCTED by combining a Fordson tractor with the wheels obtained from a large steam tractor and mounting a wooden body on them, a homemade large capacity truck is being used by a contractor of Athens, Ontario, Canada, for the purpose of hauling stone from a crusher and distributing it along a road that is being built.

The rear wheels are chain driven from a jackshaft at the rear of the tractor transmission and are wide enough so that the truck can negotiate soft and muddy country roads while carrying a couple of cubic yards of crushed stone.



How Fordson tractor was combined with steam tractor wheels

Simply by removing a panel at the rear of the truck, the load can be dumped. The owner was obliged to build his own machine because he could find no truck on the market capable of hauling similar loads over the rugged country where most of his work was situated.

New Instrument Is Played with the Feet

A MUSICAL instrument built on the principle of a piano, but in which the keys operating the sound-producing mechanism are pressed by the feet of the player, has been invented by a Western musician. The strings of the instrument are mounted on a vertical frame inclosed in a wooden case. The keyboard is placed at the bottom of the case.

There are eighteen pedals. Nine on the left side of the keyboard represent tones of the chromatic scale beginning with G below the middle C of the piano; the nine pedals on the right produce chords. Shifting of the key is effected by stops that reach across the strings and are also operated by the feet. All pedals are pivoted on the same fulcrum bar, separated by friction pads.

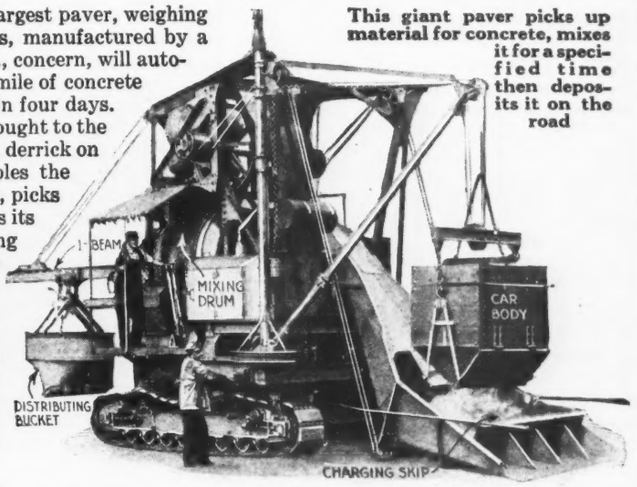
The tonal range of the instrument is too limited to make it suitable for solo work, but it supplies a satisfactory accompaniment for strings or voice.

The Editor will be glad to supply, whenever possible, the names and addresses of manufacturers of devices mentioned in this issue of POPULAR SCIENCE MONTHLY.

Paver Lays Road Automatically

THE world's largest paver, weighing over 30 tons, manufactured by a Milwaukee, Wis., concern, will automatically lay a mile of concrete road pavement in four days.

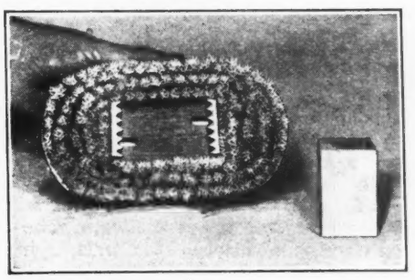
Material is brought to the paver in cars. A derrick on the paver grapples the body of each car, picks it up and deposits its load in a charging skip. The skip then rises while the car body is being replaced, and the batch is deposited in the mixer, which has a capacity of 60 cubic feet of material.



This giant paver picks up material for concrete, mixes it for a specified time then deposits it on the road

At this point a valve is automatically opened and the proper amount of water enters the mixer. A clock mechanism, called a "batchmeter," starts to operate with the mixing drum and locks the discharge mechanism so that the material must remain in the drum for a full minute. The batchmeter also counts the number of batches mixed.

After the mixing time has elapsed, the operator unlocks the discharge mechanism and the concrete flows out of the drum into the distributing bucket. The operator sends out this bucket to where he wishes to deposit the concrete, reverses the bucket and allows the concrete to flow out, while the bucket returns to its original position. The rate of return is so regulated that the amount of concrete left in one position is just enough to make a slab of the desired thickness.



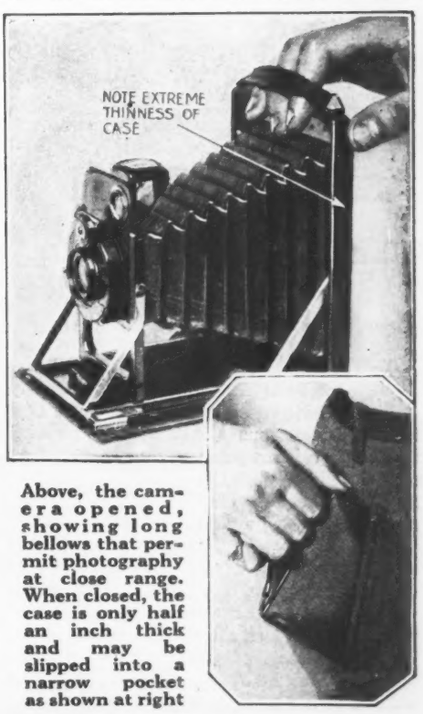
Bathbrush Holds Soap

THE latest bathbrush has in the center of the bristle side a space large enough to hold a cake of soap. The soap is held by a clamp that can be adjusted by a screw on the back of the brush as the soap becomes smaller from use.

This Pocket Camera Is only Half an Inch Thick

EXTREMELY compact, yet combining the most improved features of a large camera, a pocket camera recently perfected is only a half inch thick when collapsed. It is equipped with a long bellows extension, permitting the photographer to take pictures as near to the objective as a foot and a half. The rising and falling front permits photographing of tall buildings without tilting the camera, and without distortion.

Despite its small size, the camera may be fitted with almost any high grade lens.



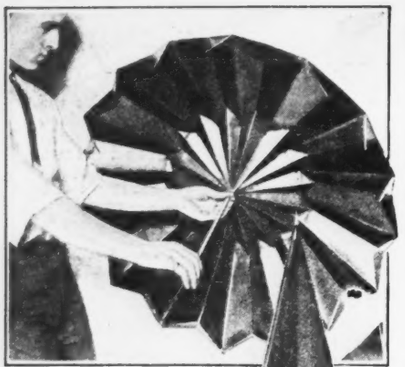
Above, the camera opened, showing long bellows that permit photography at close range. When closed, the case is only half an inch thick and may be slipped into a narrow pocket as shown at right

Corncribs Made of Chicken Wire

Around poles driven in a circle are fastened sections of wire fencing, forming graincribs. Roofs are of cornstalks

CORNCRIBS that cost little and give good ventilation for ripening and drying the grain, are built of woven wire netting by ingenious farmers in Argentina.

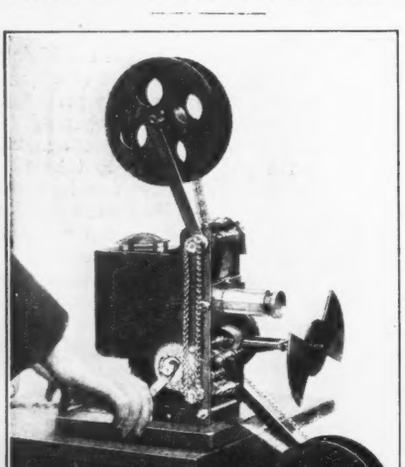
The cribs are constructed by driving eight long poles in a circle of 15 or 20 feet. Around these poles sections of wide chicken wire are fastened, allowing each section to overlap. Cribs thus formed are filled with the harvested grain and each stack is protected from rain by a cornstalk roof.



Paper Umbrella for Emergency

A COLLAPSIBLE paper umbrella that is serviceable and attractive has recently been designed and patented as an inexpensive emergency shelter for the traveler who is caught in a shower.

The umbrella is made of waterproofed paper and consists when open of two cones, the inner one of which acts as a brace (corresponding to the ribs in the ordinary umbrella). When collapsed, the umbrella is flat, resembling a bellows in shape, and can be packed in a suitcase or under an auto seat. The umbrella will withstand a 30-mile wind.



Small Projector Provides Movies in the Home

WITH a small and inexpensive home motion picture projector recently devised, any household may enjoy the best movie productions and the most popular film stars without going to the theater. The film reels used with the projector are faithful reproductions of the original feature releases. It can be bought for $35.

The films are of non-inflammable type and can be bought from the producers and exchanged just as original feature pictures are bought and exchanged by theaters. Thus any film reel, after it is purchased, can be exchanged with little added expense and the home can be supplied continually with movies of the most prominent stars.

What Do You Want to Know?

Send your questions on subjects of general or applied science to Information Department, POPULAR SCIENCE MONTHLY, 225 West 39th Street, New York City, inclosing self-addressed stamped envelope

Q. Why is the water of the sea salt?

A. Because during millions of years the rains have been wearing down the land and carrying the dust and sand from it into the sea. The solid fragments have been deposited as sand or clay on the sea bottom, but always there has been a little of the rock from the land that was really dissolved by the water and remained in solution. This is the salt of the sea, and the quantity of it has gradually increased during geologic time.

Q. What is the duty of the white corpuscles in the blood?

A. These tiny white cells, which accompany the ordinary red corpuscles in the blood, are supposed to be scavengers—the street-cleaning and waste-removal department of the body. They also defend the body against attack. When a dangerous germ gets into the blood, they surround and destroy it.

Q. Why are soap bubbles round?

A. Because of what is called surface tension. This is really a form of cohesion, the force that keeps everything from flying apart. Iron is held together in a solid mass by cohesion. A falling drop of water is round because that is the most compact form it can take, the form that agrees best with its cohesion. So with a soap bubble. It takes the most compact form it can, of course, without allowing the air inside to escape.

Q. How do we know what the stars are made of?

A. By means of the spectroscope, which is an instrument for analyzing their light and determining which chemical elements compose the glowing substance from which the light comes. Each chemical element gives out its own particular kind of light.

Q. Are there any creatures that live forever?

A. Scientists believe that certain one-celled animalcules do. These tiny creatures live in fresh-water ditches and similar places. When they have grown to full size, they divide in two, and when each half grows to full size, it divides again, and so on indefinitely.

Q. What is hypnotism?

A. A mental state in which the attention becomes so much fixed on some single thing or person that nothing else is perceived. If you are climbing down a fire-escape on a burning building, you can cut your finger without being conscious of it at all. This is a form of hypnotism. Your attention is fixed on the fire. When some one has hypnotised you, your attention is fixed on him, to the exclusion of everything else.

Q. Why isn't the air all used up by the breathing of men and animals?

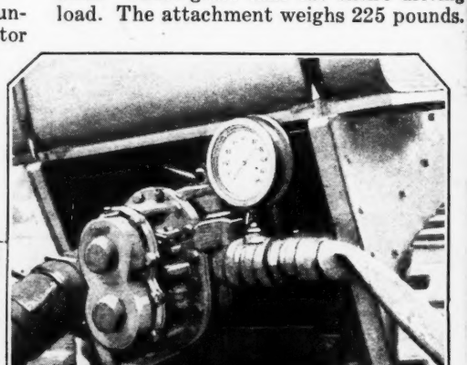
A. Because as fast as the oxygen is taken out of the air by animals, it is put back into it by plants. The green plants take out of the air the carbon dioxid exhaled by animals, and by retaining the carbon release the oxygen, which returns to the air. The plants use the chemical power of the sunlight in doing this, and by the same process produce sugar or starch, to be stored up for future use.

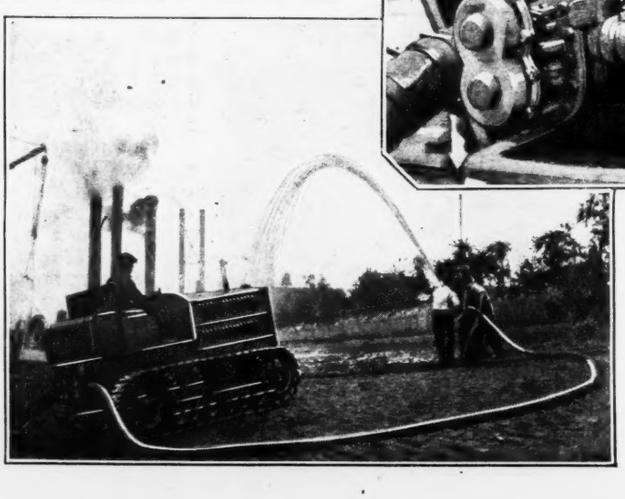
Tractor Drives Powerful Fire Pump

DESIGNED for forest fire patrol and for municipal fire protection, a rotary rear wheel pump attached to a track-laying tractor is performing excellent service. It is adapted also for use by contractors in pumping out flooded excavations, trenches, or coffer dams and as an auxiliary for irrigation work.

The pump is driven through the countershaft direct from the tractor motor and is capable of delivering 200 gallons of water a minute under a working pressure of 100 pounds to the square inch. At normal speed it throws a 1⅛-inch stream 100 feet in the air, requiring 26 horsepower. Its chief advantage, especially in forest fire patrol, is that it can travel speedily over the roughest ground.

With working parts inclosed in a heavy cast iron case, the pump is attached at the extreme rear of the tractor. Its efficiency is enhanced by the fact that the pump gears are driven from the motor shaft through closely fitted spur gears running in an oil bath. These gears take the entire driving load. The attachment weighs 225 pounds.





Attached at the rear end of the tractor, the pump is driven from the motor shaft through spur gears. Its capacity is 200 gallons of water a minute and it will throw a 1 1/8-inch stream 100 feet in the air

Would a Falling Bullet Kill You?

It Might Give You a Headache, Says Army Captain Who Describes First Scientific Tests Revealing What Happens When a Bullet Is Shot Straight Upward

By Capt. Edward C. Crossman
Late Fire Control Officer, Small Arms Ballistic Station, U. S. A.

Conducting the world's first scientific tests to determine exactly what happens when a rifle bullet is shot straight upward, Capt. Edward C. Crossman discovered astonishing new facts about the rise and fall of the regulation army rifle bullet shown at right, revealing that a falling bullet, if it hit you, probably wouldn't cause anything more serious than a headache

ON THE shelter platform, above our heads, the Browning machine gun remarked 10 times, staccato: "Tat-tat-tat-tat," while three stop watches clicked with the first shot, and commenced their busy ticking. Above us two machine gunners ducked under the cover of their extemporized steel shelf, while we stood in security beneath half an inch of armor plate covering the 10-foot-square platform of the observation tower.

The first burst of shots in the first scientific attempt ever made to find out exactly what happens when you fire rifle cartridges straight upward into the air, had just gone, and we waited to see what would happen.

This 175-grain boattail bullet remained in the air 67 seconds; yet others of the same type, discharged at the same instant, stayed aloft 107 seconds, or 40 seconds longer

Around our tower—four piles driven into the mud of a Florida lagoon, with platforms built over the piling—there stretched open water for hundreds of yards, all quiet, except for the little ripples stirred by breezes.

We stood perfectly quiet, ears alert for the splash of the returning bullets if the machine gun volley should return within earshot. Then, when the hands of the stop watches had just crossed the 50-second mark, there came a queer whirring whistle. A hundred yards or more away, something was throwing up sharp splashes on the quiet water. The 10 shots from the Browning were returning. The time from first to last shot was about four seconds.

So began a remarkable series of tests that proved conclusively that not one of the several types of rifle bullets has power enough, on its return trip to earth, to bury itself more than two thirds of its length in firm sand; nor could it inflict a serious wound if it should strike a man's head incased in any fairly firm headgear — in fact, it probably could do no more damage than to cause a headache.

Another volley from the Browning, and this time greater luck was with us. Although the bullets in this burst projected probably 9000 feet into the air, and traveled for about one minute up and one down, they fell all about the tower. And as they fell there came a yell of exultation from the machine gunners above, following a heavy "clang" and a splash of water.

"I caught it in me bucket! How's that for shootin'?" yowled a machine gunner. Sure enough, one of the returning bullets had struck fairly in a galvanized pail of water on the platform near the gun! It had merely made a dent in the bottom of the pail. Another bullet struck the pine boards of the platform where they extended slightly beyond the armor covering, making a dent about a third of an inch deep, with the diameter of a lead pencil; but the bullet did not even stick in the indentation.

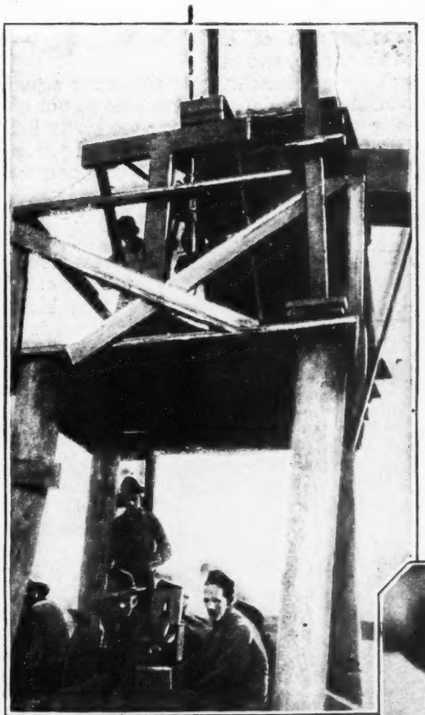
In these tests we used the standard infantry and machine gun cartridge of the American service, bullet of 150 grains, velocity 2700 feet. But when we tried out the 175-grain boattail bullets—a remarkable new type with tapering tail that doubles the range of a rifle—some of us nearly came to grief. After a minute and seven seconds there came the bullet whirr, louder than that of the service bullet, and then the usual splashes on the surface of the lagoon. Then the splashes ceased, although not all of the bullets had been accounted for. Some of the gunners had stepped out of their shelter, and the watches had been stopped—when suddenly—certainly half a minute after the burst had landed, there came again the bullet whirr. Machine gunners ducked for shelter — and down whirred eight or 10 more shots.

This 150-grain army service bullet went up nearly two miles and was gone 49 seconds before it returned, tail downward, to dig itself into the sand as shown below

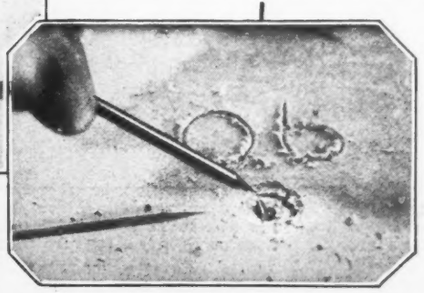
Whereupon we discovered an astonishing fact—that when fired from a machine gun, boattail bullets vary widely in their time of flight. In the next burst we found that the bullets returned in a cluster in about 67 or 68 seconds, while a second group returned fully 40 seconds later. Later we repeated this sort of firing on the hard sands of Daytona Beach, Fla., and found that the boattail bullets were as likely to return to earth sideways as to fall as most bullets do — base first. This led to the conjecture that the time discrepancy is due to the way they turn and travel on their return flight (a sidewise flight resulting in increased air resistance), and that the variations may be due in part to vibrations in the machine gun.

Normally, when fired vertically, a bullet of any sort returns in the position in which it went up. If you fire it normally, point first, it returns with the point still upward and the base downward. If you invert it in the shell and fire it with the point down and the flat base up, it returns point down and base up, but in much shorter time than the bullet normally fired.

We tried out various types of guns and bullets in this vertical firing. The results showed that almost any bullet fired into the air remained away 30 seconds or more. The little .22 long rifle, with its 1000 or 1100 feet a second velocity, took 35 seconds. The large, slow .45 automatic pistol bullet took 39 seconds. The .30-30 bullet took 50 seconds, or nearly as long as the service sharp point. The Remington .35 auto-loader bullet, 200 grains at 2000 feet a second, took 58 seconds. The quickest trip recorded was that of the 175-grain boattail, which was loaded inverted. It returned in 21 seconds, as compared with 67 to 107 seconds when fired normally.



From a machine gun mounted on the top platform of this tower, bullets were fired straight upward. Half-inch armor plate covering the lower platform protected observers from returning missiles



Not one of the rifle bullets tested returned to earth with power enough to bury itself more than two thirds of its length in the sand

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Induces Huge Tarantula to Bite Him—and Lives!

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Photo Courtesy American Museum of Natural History

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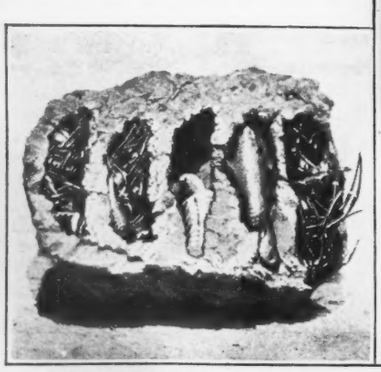
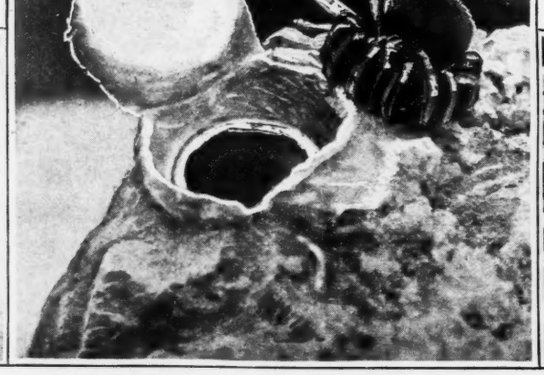


How some spiders come to grief. This wasp's nest, broken away, shows how captured spiders are stored for food



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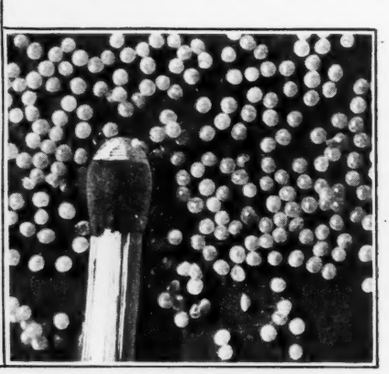
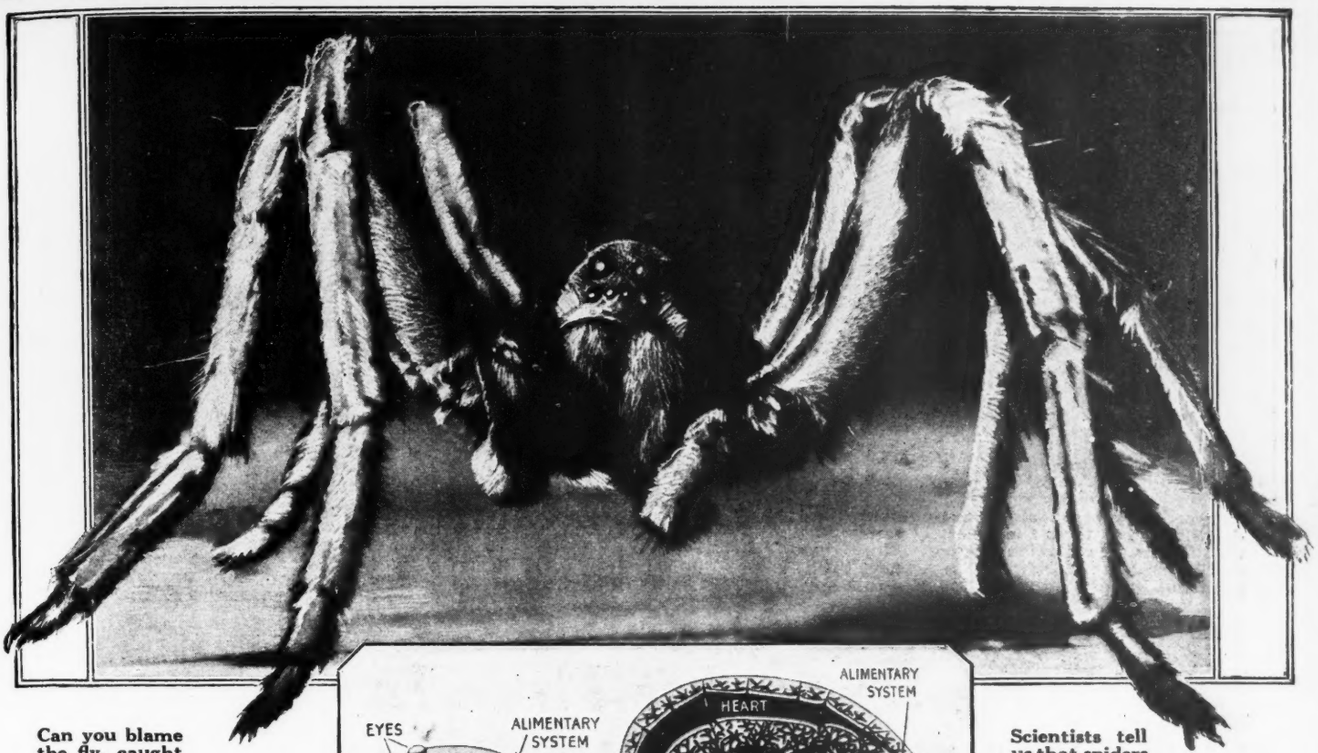


Spiders' eggs compared in size with a match head. A female spider sometimes lays as many as 500 of these eggs



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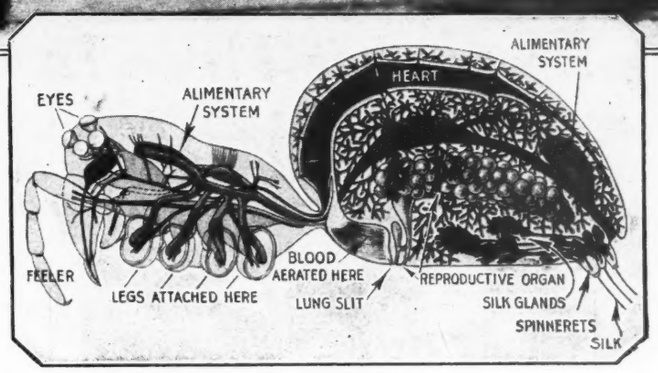

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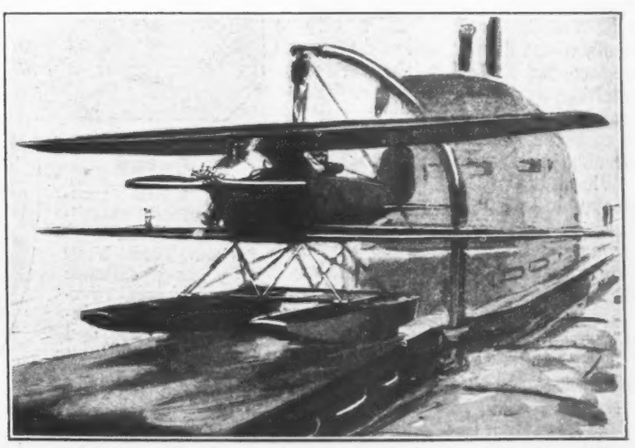

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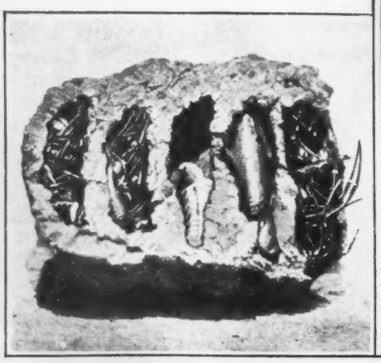

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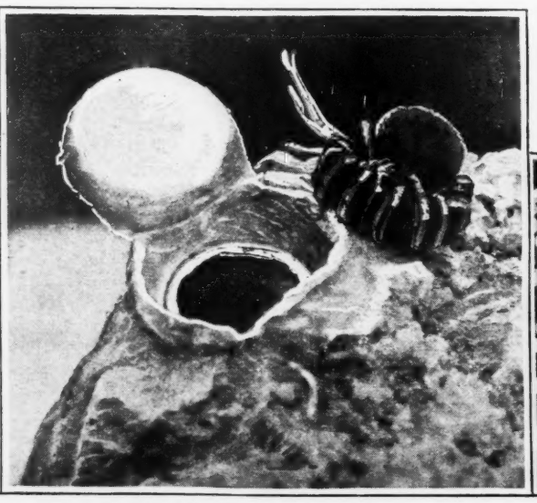

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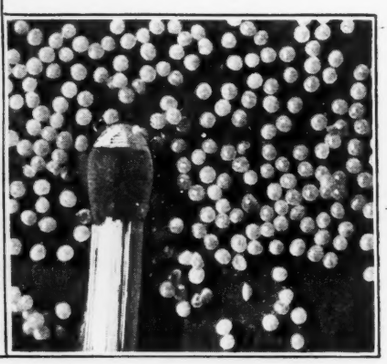

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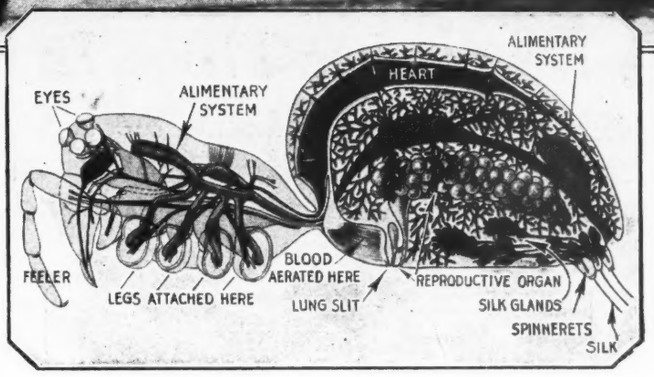

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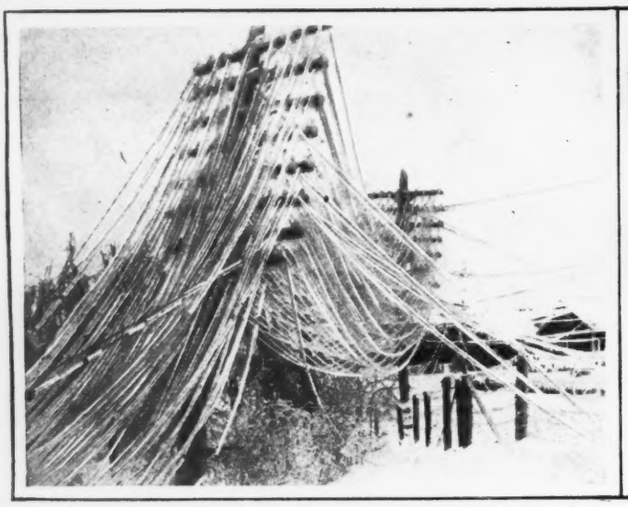
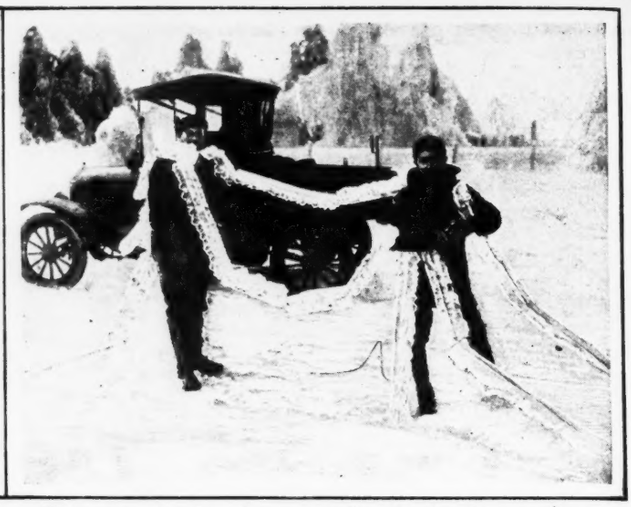


Extraordinary scene along a telephone line during the destructive ice storm that recently paralyzed communication in the New England states. More than 3700 poles and 3000 miles of wire went down under the weight of the beautiful ice mantle. Drizzling rain followed by freezing weather causes disasters such as this



When wires break under tremendous loads of ice, as shown above, marvelous instruments in the central telephone exchange instantly locate the points of trouble along the line, directing an army of repair men in their work of quickly reestablishing communication. Usually the tangled and broken wire is practically worthless

Bridging the Storm when Phone Lines Go Down

How Marvelous Switchboard Instruments Locate the Exact Spots where Wires Break and Poles Fall under Tons of Ice—Our Voices Take a Detour while Army of Workmen Rushes Repairs

By Harry A. Mount

WHEN sleet and ice turn the world into a glittering fairyland, and telephone lines go down under the weight of the frosty tinsel, there swiftly comes to the aid of American telephone companies an amazingly sensitive, almost human, mechanism, that immediately puts its finger on the breaks and skilfully directs the work of repair so that our telephone communications may be uninterrupted by the winter storm.

Switchboard a Block Long

In every large phone exchange in the United States may be found one of these ever-ready trouble finding systems, and the most intricate of them all is housed in the 23-story long-distance exchange in New York City. Here every telephone line, and most of the telegraph lines to distant cities, run to an enormous switchboard, as long as a city block, where first signals of distress are recorded, and where the work of patching up the breaks begins. The board is literally a "nerve center" of communication for a vast area surrounding America's greatest city.

When a winter "ice storm" breaks, no longer is it necessary for linesmen to tramp weary miles through sleet and snow to locate broken wires or fallen poles. In the warmth and comfort of the exchange building, the trouble seeker or tester, with sensitive instruments before him, "feels" out along the ice laden wires and spots the trouble to within a rod or two of the place where the break in the line has occurred.

The break found, his first step is to route the broken circuit over another line until repairs are made—a step made possible by the fact that by the marvelous methods of modern communication, a single wire is made to carry half a dozen messages simultaneously. The next step is to hurry a repair gang directly to the spot where the break has occurred.

Where Trouble Is Spotted

AT THIS enormous switchboard, a block long, in the New York City long distance exchange, breaks during a storm are instantly recorded, and interrupted circuits are re-routed over unimpaired lines. Note the numerous "patching" cords with which this rerouting is accomplished. At the right: A tester at his board

Wheatstone Bridge Finds Breaks

The most important instrument for locating breaks in a telephone line is the Wheatstone bridge, a simple device for the accurate comparison of electric resistances, by which an unknown resistance may be determined from known resistances. The instrument measures the resistance of the wire from the exchange to the point of break. And since the length of wire to each unit of resistance is known, the exact distance to the point of break can be quickly calculated.

The amazing speed with which breaks can be detected and located is illustrated by the following incident:

Not long ago a native of Pennsylvania conceived the idea of stealing a section of copper wire in a lonely spot midway between two towns, and selling his loot for junk.

The instant his pliers nipped the wire, however, the fact was recorded on a test board in New York, the break located, and crews despatched by telephone from the nearest town. The result was that

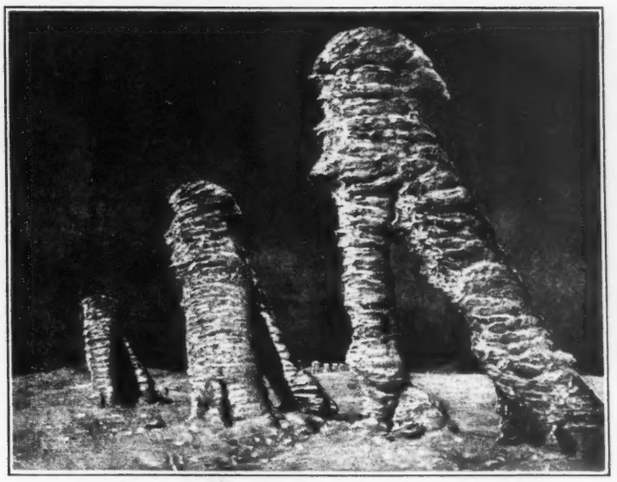
the thief was caught red handed before he could even load the wire on his wagon.

Small breaks located by the Wheatstone bridge and other instruments of the telephone's nerve center, are easily repaired while service goes on uninterrupted. But when a great storm occurs and line after line goes down, immediate mobilization of repair forces and of spare equipment begins.

Trouble Army Mobilizes

In effect the emergency organization is military. In command is a general, whose word is law. After a hasty survey of the situation, men, materials, and equipment begin to move into the stricken area from every available point. Each of four sectional branches of the telephone company usually keeps a reserve of about 35 miles of No. 12 wire, and 1600 cross arms and fittings for poles. Sometimes even these supplies are inadequate to cope with the damage done by storms.

Sleet and ice cause greater property damage than all other varieties of storms combined. Only last winter, on the day before Thanksgiving, New England was visited by one of these storms, the second largest in point of damage done in more than 50 years. Broken, twisted forest trees, and a shattered maze of dead undergrowth are mute evidences of the disaster. In that storm 3200 telephone poles went down. Massachusetts, Vermont, and part of Connecticut were cut off from communication with the rest of the world for several days.



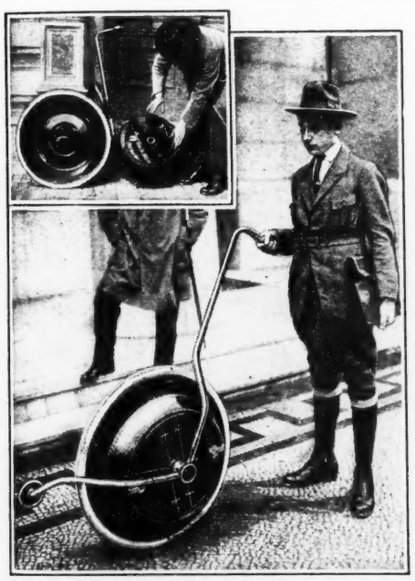
Freaks of the Storm—What Are They?

No, they aren't ancient ruins—just ordinary telephone poles loaded with tons of ice during a recent storm in Alaska, exemplifying one of the problems the linesmen are up against

Some Famous Storms

In a similar storm in 1914, more than 3700 poles were put out of commission between New York and Philadelphia, and the year before, 700 poles went down within a radius of 50 miles north of Troy, N. Y., from the same cause. Similar storms occur two or three times every winter.

To repair the break which occurred in New England last year nearly 3000 miles of wire was required, and yet within two months the entire system was repaired. Temporary service was restored within five weeks.



Monocycle Is a Substitute for the Market Basket

A ONE-WHEEL, hand-pushed cycle, the wheel of which incloses a cylindrical container, has recently been placed on the market for transporting bulky books and documents, or as a handy, practical substitute for the housewife's market basket.

To the container, which is fastened at the center of the wheel so that the wheel rim revolves about it, is attached a long curved handle by which the operator pushes the device along the street. The container will carry either solids or liquids.

The rim surrounding the container has a rubber tire. Used as a trailer to a motorcycle or bicycle, the ingenious monocycle provides a ready means of carrying loads weighing as much as 100 pounds.

THE EDITOR will be glad to supply, wherever possible, the names and addresses of manufacturers of devices mentioned in this issue of Popular Science Monthly.

Steel Bar Bent with a Visiting Card

WHEN you press the edge of a calling card on the top of a steel bar 4½ inches thick and 20 inches long, solidly supported at both ends, will the bar bend? It certainly will, improbable as it may seem. In fact, with a homemade apparatus, you yourself can easily measure the deflection, which is about a millionth of an inch!

The measurement is performed with a simple optical device that consists of two pieces of plate glass at least one quarter inch thick with a strip of tinfoil between them at one edge. These strips of glass are placed on the under side of a piece of angle iron rigidly connected with the billet, the deflection of which is to be measured.

The upper glass is fastened to this iron bar and to the lower strip by an adjustable thumbscrew. The tinfoil keeps the two glass surfaces from contact. A hole through the angle iron over the center of the glass makes the deflection visible.

If you place this arrangement in front of a light, tighten the thumbscrew until the plates of glass are nearly parallel, and look through the hole, you will see a series of alternate light and dark bands crossing the glass. Lay the visiting card on the steel bar, and these bands will move to the left. Press upward from beneath the bar, and they will move to the right.

To measure the movement accurately, sprinkle table salt in the flame. The resulting yellow light will have a wave length of about 1/50,000 inch. As each light wave produces both a light and a dark band, if the sidewise movement equals the width of one band, the deflection of the bar evidently amounts to 1/100,000 inch. You will probably find the actual movement about one tenth of this, so that you are measuring a movement of a millionth of an inch.

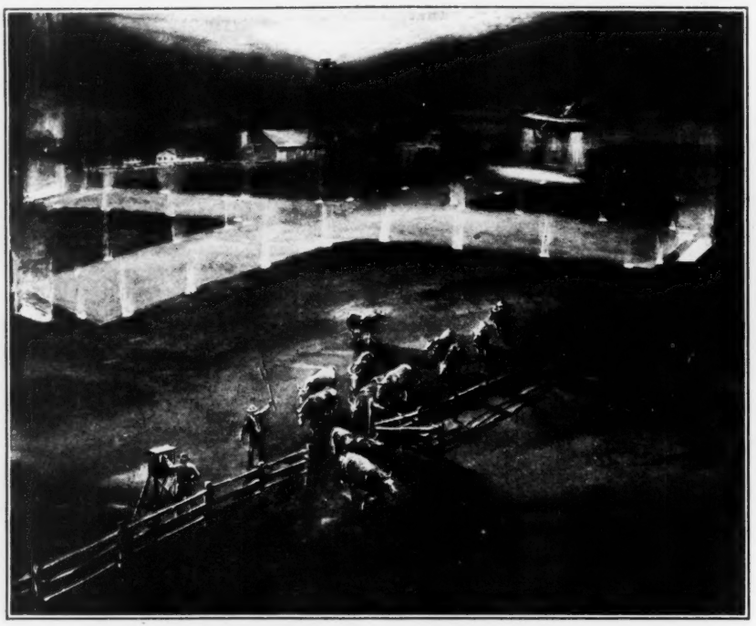
The apparatus is based on the undulatory theory of light. The eye sees two groups of rays, one reflected from the bottom of the upper glass strip, the second from the top of the lower one. These last rays must cross the air space between the glasses, which is adjusted until it is half the light-wave length.

With this simple optical device, deflection of a 4½-inch steel bar by a visiting card can be measured, even by the layman, to one millionth of an inch

Analyzing the Measuring Process

In this way the two waves meet at the eye crest to trough, and destroy each other, producing a dark band. Where the air space is a full wave length wide, the waves meet crest to crest and produce a brighter band.

Pasture Airdromes for the Night Air Mail



Above: One of the powerful guiding beacons for a landing field, constructed by the U. S. Post Office Department.
At left: A pasture landing field, the farmer driving his stock home, while a helper turns on the lights

NIGHT flying over transcontinental air routes is expected by government officials within the next six or eight months, making it possible to shoot mail through the air from New York to San Francisco within 28 or 30 hours, thus reducing delivery time by four days.

The latest plans of the Post Office Department are for brilliantly lighted emergency and permanent landing fields for mail planes, strung across country at intervals of 25 miles.

A mail service field near Chicago is being used as a laboratory, where all kinds of lighting systems for these fields will be tested. According to a well-planned scheme already developed, each of the landing fields will be lighted by a beacon, placed on a tower 75 feet high. The beacon can be seen from a distance of 35 miles, and will be easily visible to pilots, even at high altitudes. Farmers who lease the fields to the government will be permitted to use them as grazing fields, but will be required to switch on the lights every evening, and keep them burning until the mail flyers pass.

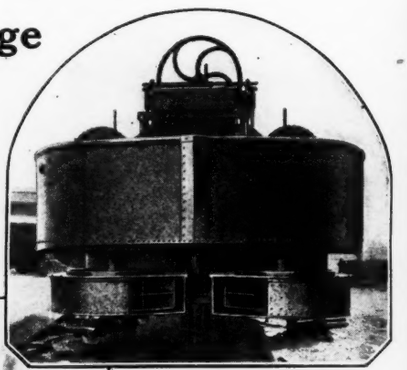
In the center of each landing field there will be two cinder runways, each 150 feet by 300 feet in dimension. These will intersect to form a cross. Their purpose, of course, will be to allow aviators to descend on a cinder path, no matter which way the night wind may be blowing. At the end of each path will be placed a flood lamp; the one opposite the approach end toward which the wind is blowing will be dimmed or extinguished. The other lamps will light up the cinder paths without blinding the aviator as he lands against the wind.

Below the surface of the ground, at intervals, around the boundary of each runway, will be placed electric lights equipped with heavy protective plate glass hoods. On the permanent fields, hangars will be illuminated by numerous gooseneck lamps, as well as by "daylight perspective" illumination, to make the structure clearly visible by night and day.

The roof of the new Chicago Post Office has been equipped as a landing field, and other new post offices will be built with the same idea in view.

Each mail plane will be equipped with two strong searchlights for locating emergency and permanent fields, and for making observations. Under the system planned, the average plane will carry 500 pounds, or 22,500 letters, of New York-to-San Francisco mail.

Submerged Blowers Propel and Guide Barge



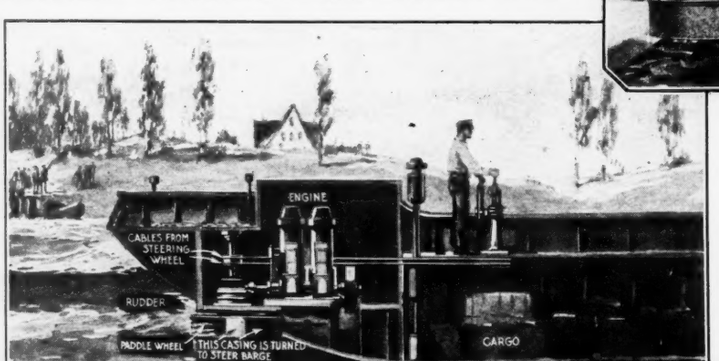
COMPLETELY submerged, horizontal paddle wheels, so mounted that they can be used as rudders, have recently been introduced by a French company for canal barges and other craft using artificial waterways. In the past, navigation of barge canals has been hindered and their usefulness destroyed by the churning of vertically working turbines and paddles. Mud from the bottom flung to the sides, has narrowed the channels and hindered navigation.

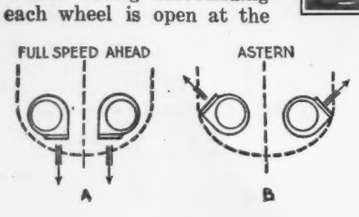
Two of these paddle wheels are located directly under the stern of the barge, the motor chamber being immediately above them. The horizontal action of the paddles, and the fact that they are partially incased in a screen, eliminates churning of the water to a large extent, and so prevents damage to the bottom of the canal.

The casing surrounding each wheel is open at the top, and also has an opening at the side that extends over nearly one quarter of the circumference. Water entering the top opening is pushed out the side opening by the action of the paddle wheel propelling the barge.

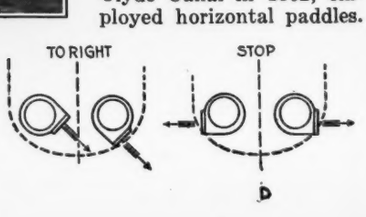
Changes in speed and direction are obtained by turning these cased wheels, and consequently changing the position of the openings. This is accomplished by the engine that drives the paddle wheels, controlled from a platform directly in front of the engine.

It is interesting to note that the first steamboat, the "Charlotte Dundas," designed by William Symington, and successfully operated on the Forth and Clyde Canal in 1802, employed horizontal paddles.

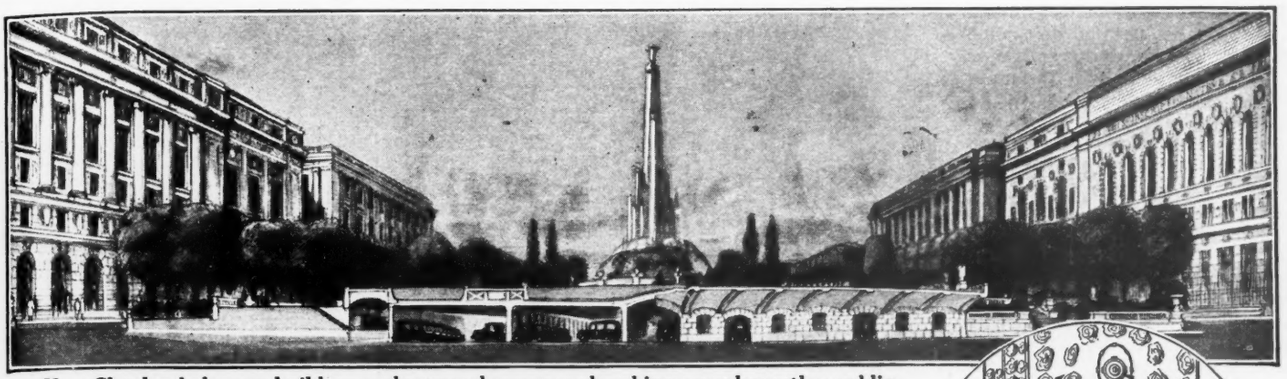




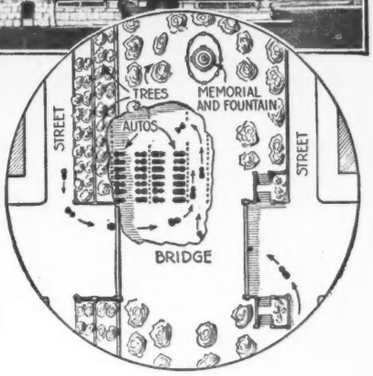
Completely submerged under the stern of the barge, as shown above, the two paddle wheels are used in controlling the movements of the barge. The propellers are inclosed in flat, cylindrical casings, with openings in the top and sides (see upper photograph). Water entering the top openings is "blown" horizontally through the side openings by the action of the paddles. Thus the position of the side openings governs the speed and direction of the barge, as indicated in the diagrams



City Plans Underground Parking Space for Autos



How Cleveland plans to build an underground garage and parking space beneath a public park. Entrance to the parking space will be from a depressed street, bridged by the mall



PRESSED by the increasing need for additional parking space for automobiles, the city of Cleveland, Ohio, is planning to install the first underground municipal garage. Cleveland's lead probably will be followed in New York City.

Cleveland possesses an ideal site for underground parking—an expansive mall or open public park, about which is being built a group of great public buildings, all of Roman architecture. Four of these buildings have been completed.

The mall, 1800 feet long and 600 feet wide, running from the post office north to the Lake Erie front will be bridged so as to create underground space for a municipal garage and parking place running the entire length of the mall. The entrance will be from St. Clair Street, which now runs through the center of the mall. This street will be depressed and bridged by the mall, thus providing an easy entrance to the underground garage.

Initial plans call for sufficient space to accommodate 500 cars. This capacity will be increased if the plan proves successful financially. Law Director Paul Lamb, of Cleveland, who with Francis Swales, of Yonkers, N. Y., devised the plan, estimates that the city should receive a net profit of $81,000 a year from the 500-car parking space. "It will offer no more mechanical problem than if it were an open parking space," he says. "It will be used exclusively for parking, although there may be a repair shop in connection with it."

Traffic Commissioner John A. Harriss, of New York City, is considering plans along the same general lines. In the case of New York, Doctor Harriss would utilize space excavated under Central Park to take care of hundreds of automobiles which might otherwise clog the city's traffic.

Electric Loom Weaves Elaborate Designs from Metal Photos

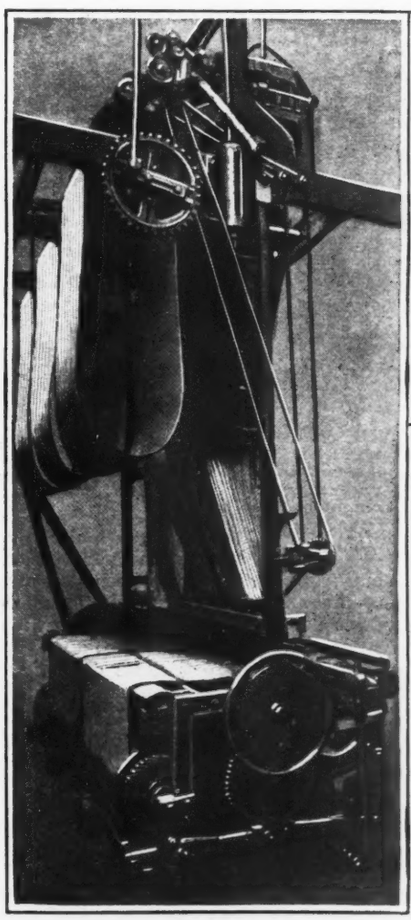
ANY home, club or hotel may now own linen and other fabrics of individual design at reasonable cost as the result of an invention by Dr. T. A. B. Carver, of Belfast, Ireland. He has devised an electrical loom that makes use of metal photographs and electrical currents in transferring the artist's original design directly to the automatic weaving mechanism.

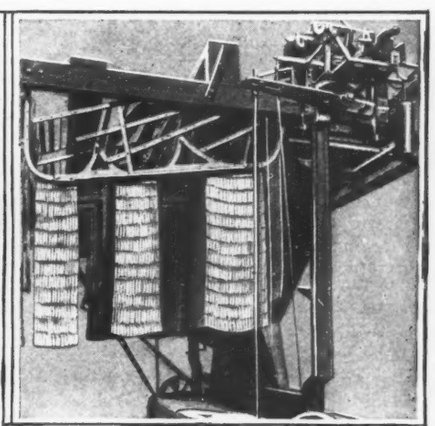
Why Linen Is Expensive

Heretofore the weaving of figured linen has been accomplished by the use of ingenious card patterns, punched with numerous holes, each perforation corresponding to one of the thousands of threads to be lifted in the loom. A series of these cards constituting a complete record of the design, is placed on the automatic loom mechanism in such a way as to actuate the lifting of the warp or lengthwise threads, and passing the woof, or crosswise threads, beneath. The cards must be carefully and accurately perforated, and since one series of cards recording a single design may represent a total length of 3000 feet, the process has been tremendously expensive. In some cases the manufacture of a single piece of fabric may entail nine months of labor and a cost of more than $6000.

The new machine, it is claimed, reduces the time from months to hours and the expense from thousands of dollars to a few dollars. The design is photographed upon a thin aluminum band or record treated chemically so that when it is later immersed in a chemical bath, certain points that are to reproduce the design become electrically conductive. The aluminum band is then placed on a rotating drum and brought in contact with an electrical apparatus that governs the operation of the loom. By this apparatus, an electrical current passing through the many small conducting points on the metal record completes circuits that actuate electromagnets. These magnets, in turn, attract levers that raise or depress the warp and actuate the throwing of the woof shuttles through the openings thus provided. The non-conducting points of the record break the circuits and release the levers.

Thus, a 12-foot metallic band, which can be manufactured in a few hours, has been used to supersede 3000 feet of cards!





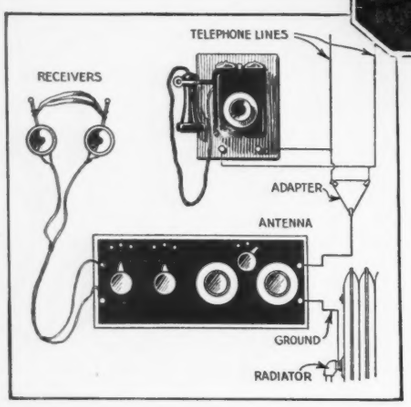
Above: The usual method of transposing a design to the loom by perforated card records. At left: The new way, using chemically treated aluminum bands on which the designs are photographed

Phone Wire Aerials for Radio Service

THE practicability of general public use of telephone wires as radio aerials is being demonstrated in the state of Washington, where the Seattle Radio Association—a broadcasting enterprise—and the Puget Sound Telephone Company have entered an agreement by which any telephone subscriber, using a newly invented adapter, may convert phone lines into an aerial for his receiving set. This arrangement is especially valuable for radio fans who are unable to erect aerials because of unfavorable locations or landlords' restrictions.

The agreement provides that the radio association will supply the adapters at cost to the telephone company, which will install them on the lines of the subscribers to the service. The association will also supply radio programs to the telephone company, which will forward the programs to the subscribers by mail. The association also agrees to furnish a broadcasting service of high quality. The subscriber to the service pays a fee of five dollars a year to the telephone company, 50 per cent of which goes to the telephone company for its services in forwarding the programs and installing the device and 50 per cent to the association for providing the broadcasting programs.

Hooked up with the wired telephone lines and with the antenna post of the radio receiving set, as shown in wiring diagram at left, the adapter converts the telephone wires into a wireless aerial without interfering with telephone conversations



The new adapter, showing binding posts for connections with telephone wires and with radio receiving set

The adapter, modeled somewhat along the lines of the aerial condenser plug, consists of an arrangement of condensers the outer plates of which are connected with the telephone lines and the inner plates with the antenna post of the receiving set.

Knocks Sun from Windows

MERCHANTS can overcome dazzling and objectionable sunlight reflections in plate glass show windows by lighting important objects in the window display with high power spotlights, according to statements made at a recent convention of the Illuminating Engineering Society.

Car Rails Welded and Laid in Long Sections

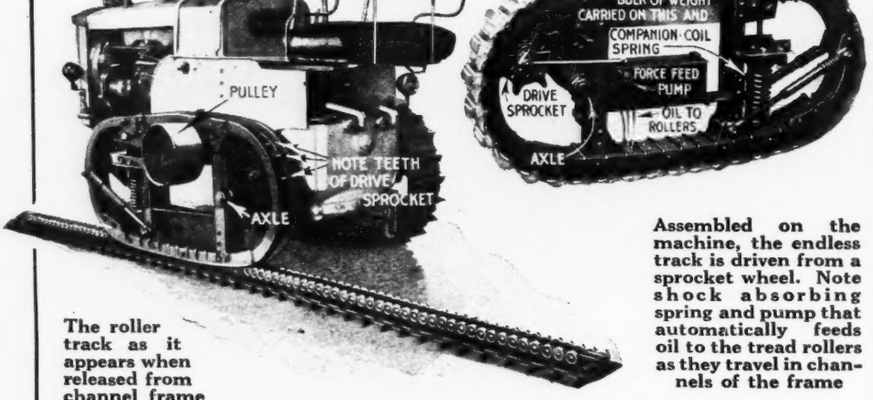
BY WELDING together several lengths of rail and laying the long sections so formed, a street railway company of Washington, D. C., found it possible to replace tracks on an entire line without interrupting traffic.

The work of welding the rail lengths was accomplished during the daytime when traffic was heavy. The completed sections were placed at the edge of the track and installed during the early hours of the morning.

In one case a pair of rail sections, each consisting of seven rails, and with a total length of 420 feet, was so installed.

Seven rails, welded together into one, are laid at one time

Endless Tread Runs on Steel Rollers



The roller track as it appears when released from channel frame

Assembled on the machine, the endless track is driven from a sprocket wheel. Note shock absorbing spring and pump that automatically feeds oil to the tread rollers as they travel in channels of the frame

A NEW "track laying" tractor, the entire weight of which travels on anti-friction rollers, has been designed to minimize wear and "knocks." Advantages claimed are: that it covers a wide range of duty without change of cleats; that its self-cleaning cleats do not fill with earth; that it increases the amount of motive power delivered to the drawbar, and that it makes shorter turning possible.

The tractor treads travel around a channel framework on a double endless chain of hardened steel rollers. The treads are so constructed that each part is replaceable. They are driven from an eight-tooth sprocket located on the countershaft, all other wheels and gearing being dispensed with.

Lubrication of the track roller, effected by a force feed pump driven from the hub of the countershaft, is automatic because the pump will run only when the track is in operation. Most of the weight of the machine is carried on coilsprings that can be tightened at will to meet conditions.

Protruding from the left side of the tractor frame is a driving pulley for belt work. This pulley receives its power through the same friction clutch in the flywheel that transmits the power to the tracks.

The First Successful Color Movie

How an Inventor, by Ingeniously Combining Blue-Green and Red-Orange on Double Photograph, Tricks Our Eyes into Seeing Delicate Shades of All Colors, Vividly Representing Life

By Thomas Elway

WHEN I was told, a few weeks ago, that another new process for taking motion pictures in color had been "perfected," I confess I smiled skeptically to myself.

I had seen many colored movies before. They had left me either unimpressed or thoroughly displeased.

To be sure, I knew that this new method had been invented by a scientist of distinction—Dr. Daniel Frost Comstock, of Boston—and that 10 years of patient research and experiment had gone into its development. I was told that more than $1,000,000 had been spent upon these experiments; that the enterprise had the financial backing of no less a figure than William Travers Jerome, former District Attorney of New York, and that artists and motion picture experts who had seen the film hailed it as a phenomenal improvement, charming in its colorful realism, lessening eyestrain, and destined to revolutionize motion picture work.

A Colorful Dream Comes True

And, finally, I had fully shared the great dream of motion picture enthusiasts during the past decade—the dream that the movies some day would be shown to us in all the beauty of natural color, enhancing enormously the power of their appeal.

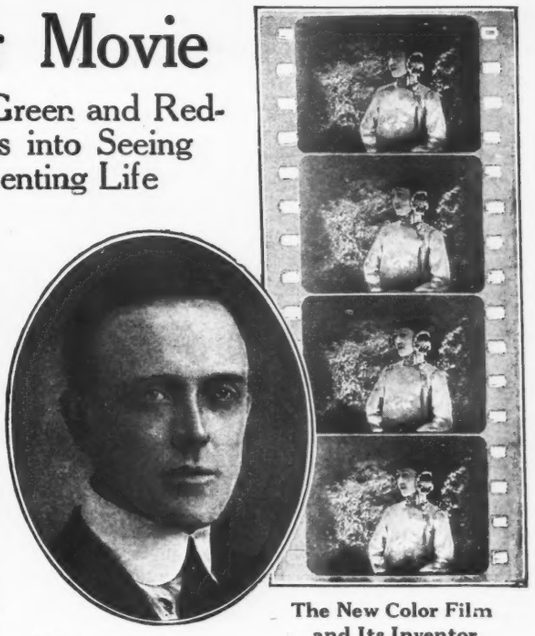
Nevertheless, I did not realize the art had advanced far enough to make this dream a reality. But when I witnessed the private exhibition in New York of this new colored film feature—a play called "The Toll of the Sea," starring the young Chinese girl, Anna May Wong, whose fame has begun to spread eastward from California—I was frankly surprised by the unexpectedly high quality of the color work. Here was a film in which colorful costumes and feminine beauty moved convincingly across the screen, with slight trace of the garishness, flicker, and distracting color fringes that have hurt so many other color films.

Not that this color work is perfect. Some of the reproductions of blues and greens are bad. The yellows are even less satisfying. But this motion picture does constitute, to my mind, the best color work done so far in the films, and the process used, the new Technicolor process, promises still better things to come. For the first time I have begun to expect something really big from color photography on the screen, something that will affect the fundamentals of motion picture art. It isn't only that we may expect enhanced charm of settings, and still greater beauty of feature in our heroines; or that we shall see them blush real blushes, as we now see them weep real tears; that expressions will be more lifelike, costumes more fascinating, natural scenery more magnificent.

A successful color movie can do something much more fundamental than this. It can give us not merely an improved art, but a new art; a new kind of dramatic production, differing from the present productions in black and white as completely, perhaps, as these differ from the productions of the spoken stage.

How can this be? Because color alone, pure color, has a powerful appeal to the human mind. This is always the great aim of drama—to seize on the emotions, to contrive that you are completely "carried away" by the thrill, sentiment, joy or sorrow of the play.

There is no doubt that color has this appeal. Red excites and stimulates us;

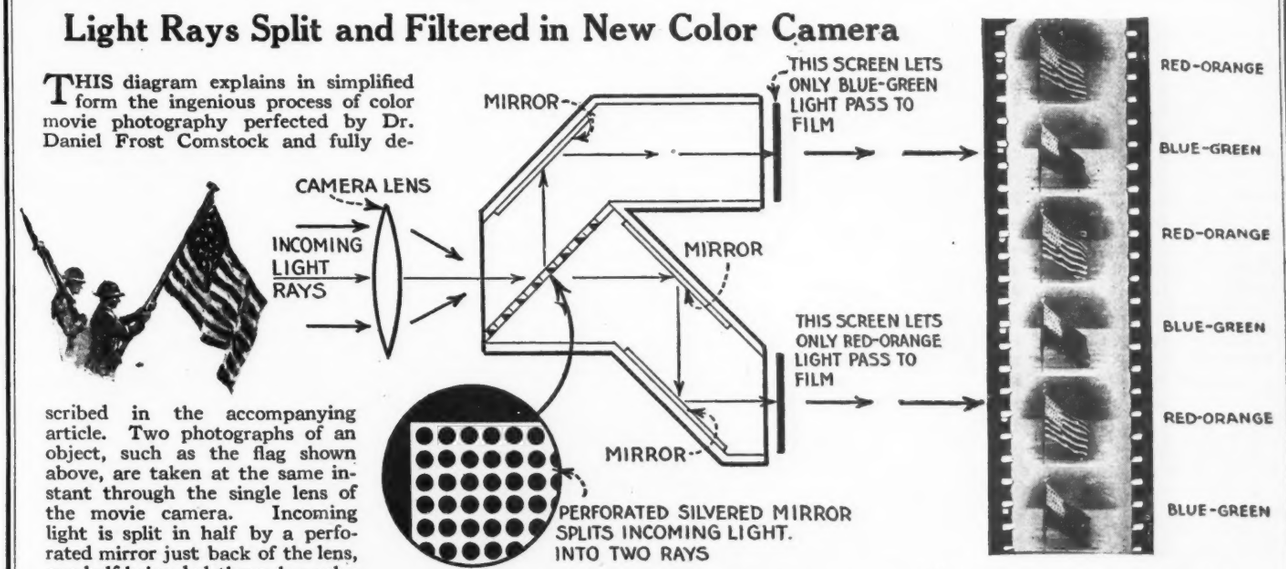


The New Color Film and Its Inventor

HERE is an exact-size reproduction of a section of the new color motion picture feature film, "The Toll of the Sea," starring the young Chinese actress, Anna May Wong. This lifelike movie made possible by the remarkable color process invented by Dr. Daniel Frost Comstock (inset), is called by the artist, Maxfield Parrish, "highly successful from a color point of view and an invention with endless possibilities—a revolution in the moving picture art"

Light Rays Split and Filtered in New Color Camera

THIS diagram explains in simplified form the ingenious process of color movie photography perfected by Dr. Daniel Frost Comstock and fully described in the accompanying article. Two photographs of an object, such as the flag shown above, are taken at the same instant through the single lens of the movie camera. Incoming light is split in half by a perforated mirror just back of the lens, one half being led through a color filter that allows only blue-green light to reach the film negative, the other half led through a second color filter that allows only red-orange light to pass to the film.



Thus the film negative of the flag, shown at the right (slightly reduced), consists of a succession of double images, alternating blue-green and red-orange impressions, but still in black and white. In the positive print of this negative, the blue-green and red-orange images are superimposed, one on the front, the other on the back of the positive film. The positive film then is dyed, the blue-green images taking blue-green dye and the red-orange images red-orange dye.

When projected on the screen, the film gives the effect of reproducing all the original colors of the flag in their natural shades.

George Fitzmaurice, Movie Producer, Says:

"AS TO whether color photography will enhance the dramatic quality and realism of the picture—that is rather hard to tell. I cannot see where natural color will detract from the drama so long as the color remains neutral and unobtrusive.

"Still, I think that the great progressive step will be taken when stereoscope photography has been fully developed. And the millennium will come when stereoscopy and color combine to produce the perfect whole."

Rupert Hughes, Motion Picture Writer, Says:

"IT SEEMS to me that color processes in motion pictures will probably follow the same line as in book and magazine illustration: for certain special effects they will furnish great charm, richness, and contrast, but for general use the single-tone pictures will enormously prevail. It would be ridiculous to deny the beautiful possibilities of occasional color, though I cannot believe that it will ever drive the monochrome, or one color, process off the screen."

green is restful and sedative. To play on people's minds with color as we now play on them with moving images or written words, will require, of course, a completely new kind of directing. There will be new lighting, new make-up, a new technique of screen acting.

But first there is a scientific problem—Can it be done? Is the color movie an accomplished fact?

As yet we cannot say that it is. But we can say that it promises to be. The new process we are discussing is a long step toward the fulfilment of this promise.

A College Professor's Vision

This process is a professor's dream come true. Ten years ago, Dr. Daniel Frost Comstock was a professor of physics in the Massachusetts Institute of Technology. He knew a good deal about color photography. He dreamed of applying it to motion pictures. With Mr. Herbert T. Kalmus, his partner in an engineering firm, he went to work. They began experiments. They organized the Technicolor Company and gathered a group of able scientists and engineers.

For years the experiments failed. Finally, success began to come. One by one the worst of the technical difficulties were overcome: the difficulty of taking two pictures at once through the same lens; the difficulty of finding the two dyes that were exactly the right ones to use in coloring the film after it had been photographed; the many difficulties that came from the extreme weakness of the light after it had passed through the complicated system of lenses and prisms required for the color camera. Film shrinkage, too, was overcome and the many other obstacles that stood in the way of making the two differently colored images fit exactly one on top of the other when they came to be printed on the same strip of film.

Probably you have heard color photographs described as "two-color" or "three-color." Doctor Comstock's films use only two colors to produce the effect of six. To understand what this means, we must recall a few facts about the nature of color and about color vision.

Ordinary white light like sunlight is made up, you remember, of six primary colors: red, orange, yellow, green, blue, and violet. You can prove this by putting a glass prism into a beam of sunlight, and noting how it splits the white light into a strip of these colors, a spectrum. You see them in a rainbow.

White light is believed to be made up of waves or vibrations of various lengths, each wave length producing a distinct color sensation. Red light from a red glass lamp globe looks red because the waves producing the other five color sensations are held back by the red glass. The orange, yellow, green, blue, and violet waves are absorbed. Only the red waves get through. Similarly a blue globe lets through only blue light, and so on. A red paint or dye is merely a substance that reflects only red light, absorbing all the others. A yellow paint reflects only yellow light, etc. These are the physical fundamentals of colors.

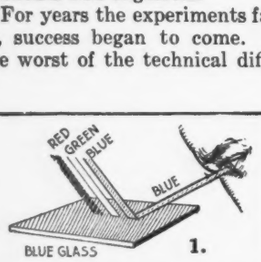
How Our Eyes Mix Colors

But this color theory is partial. It leaves out the human eye. You look, for instance, at an apple. Something happens in your eye. You have a sensation of redness, an impression that the apple is sending red light into your eye.

This seems straightforward enough. The eye, you say, must contain some mechanism able to perceive red light as such, able to sort out the light of the six different primary colors and recognize each for what it is; to recognize each color by itself. What could be simpler?

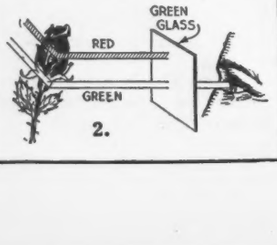
It is simple, true enough, but it is not what happens. Make an experiment. Take

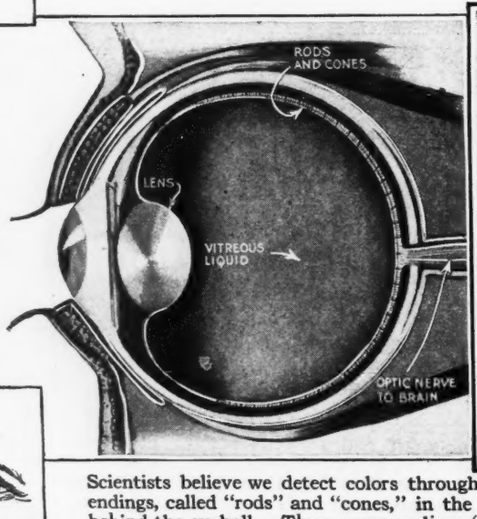
Facts Explaining How We See Color and How Color Screens Work

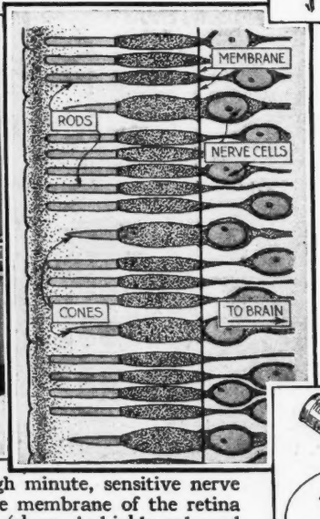


Sunlight contains rays causing all color sensations. Light from a blue glass looks blue to us because the blue glass absorbs all the light rays except the blue rays that it reflects to our eyes

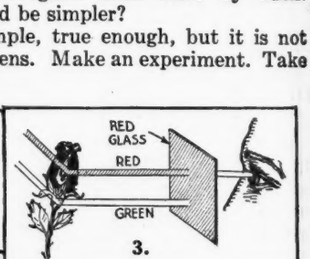
Below: A green glass absorbs the red rays from the rose, but allows the green rays from the stem to reach the eye





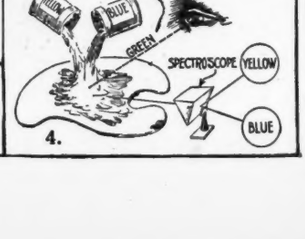


Scientists believe we detect colors through minute, sensitive nerve endings, called "rods" and "cones," in the membrane of the retina behind the eyeball. These nerve endings (shown in highly enlarged cross section at upper right) transmit light stimuli to the brain



Above: A red glass absorbs the green light waves, allowing only the waves that produce the red sensation to reach our eyes from the rose

Below: Analyzed in front of a spectroscope, a mixture of yellow and blue paint is found to produce yellow light and blue light; yet our eyes, in blending these lights seem to see green



Marcus Loew, Owner of 75 Theaters, Says:

"I RECENTLY witnessed a showing of a colored moving picture of the Chinese story called, 'The Toll of the Sea,' which was shown by Judge William Travers Jerome. I thoroughly enjoyed the picture and consider the process highly successful.

"The picture was made far more effective and convincing by the soft, wonderful coloring."

Charles Dana Gibson, Artist-Illustrator, Says:

"I HAVE seen all the color processes so far, and the new process represented in the picture, 'The Toll of the Sea,' is far and away the best. The effect is convincing and most restful to the eyes and altogether irresistible.

"I am looking forward to seeing the picture again.

"It is my belief that this new process will revolutionize the motion picture industry."

some yellow paint and some blue paint and mix them. What do you get? You get *green* paint.

This fact is so familiar that we are apt to forget how startling it is. Think for a moment of what it really means. There are six primary colors. These are separate physical things—different kinds of light. You mix two of them, yellow and blue. You do not get a mere mixture, a yellowish blue or a bluish yellow. You get a third *primary* color, totally different from the yellow and blue, another one of the original six!

What is the explanation? Simply this: The mix-up is in the human eye. The eye does *not* perceive the six primary colors separately and individually. It confuses and blends them in a very complicated way.

Green Isn't Green

Take, for instance, our mixture of yellow and blue paint. Put this in front of a spectroscope, and analyze the light from it. You get yellow light and blue light—no green light at all. Physically, the mixture of paint reflects just the lights that the two separate paints did. The blending of these lights to make green is done, somehow, in the eye. The eye is fooled. It really sees blue plus yellow. It thinks it sees green.

There are innumerable other ways to fool the eye on colors. For instance, mixed red and green (of the proper tints) look white. Certain yellows and certain violets, when mixed, also look white. The eye is simply unable to distinguish between a red-green mixture that looks white, a violet-yellow mixture that looks white, and a true white containing all six spectrum colors.

The theory for all this is very uncertain. In the membrane that lines the back of the eyeball—the retina—there are two kinds of minute nerve endings—the rods and the cones. It is supposed that we detect colors through the sensitiveness of these nerve endings to different light vibrations. It used to be believed that the rods saw red and green and the cones saw blue and yellow. This was disproved. Then it was believed that the cones saw all colors, while the rods saw only light intensity, that is, differences between light and dark. Now even this is doubtful. The plain fact is that we don't know how we see. We know only that the mechanism is extremely complicated, that color vision is especially so, and that, somehow or other, the nerve endings in the retina are variously stimulated by various wave lengths of light, and transmit the stimulus to the brain, where the consequent perception of varying colors is produced.

How Constance Talmadge Would Make Up for Color Movies

ON THE right side of this popular star's portrait are indicated the points in her make-up for black-and-white movies. See how entirely different is the make-up she will be likely to use in color movies, indicated on the left side of the picture. This probable make-up is based on results of recent experiment

But perhaps you are asking what all this has to do with color movies. It has everything to do with them. Color movies are possible at all only because we *are* able to fool the eye about colors.

The new Technicolor process, for instance, is a "two-color" process. This means merely that we dye the films with two colors only, but by mixing them in different proportions we are going to try to represent all colors. A mixed red and green, you remember, will look like white. We are going to extend this. We are going to choose two colors, make various mixtures of these two colors and fool the eye, if possible, into thinking that it recognizes in these mixtures all of the six primary colors.

The best proof that this can be done is that it *has* been done. As you view a two-color film like "The Toll of the Sea," you think you see all the colors. With a few exceptions to be noted later, the eye is fooled successfully enough.

Two-Color Dyes

In this particular feature, as in most other color movie processes, the two colors selected are a reddish orange and a bluish green. These colors are represented by two dyes, carefully chosen from more than 200 dyes that were tried. As I shall explain later, the original photograph consists of two separate images. One image, printed on one side of the film used in projection, is dyed blue-green; the other, printed on the reverse of the film, is dyed red-orange. Where the images overlap, these dyes blend. In projection onto a screen the light is colored by the dyed images, the colors blend likewise, we see both images together, and the eye does the rest.

What we really see are various shades and mixtures of blue-green and red-orange. What we think we see are all the colors of the spectrum. It all depends upon the capacity of the eye for being wrong about colors. It is just like the rabbit that you think you see coming out of the conjurer's hat.

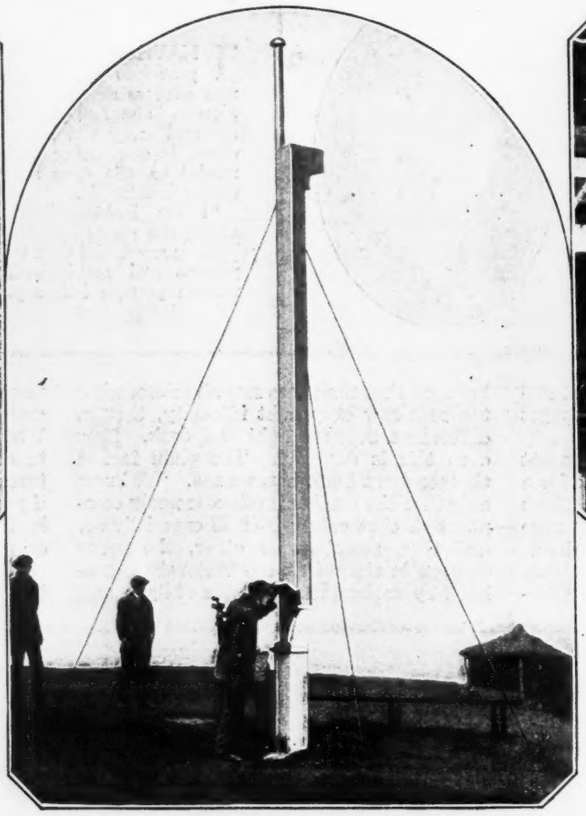
This is what the two-color photograph is, but how is it taken? In exactly the same way. You take two photographs at the same time, one through a screen that lets pass only the blue-green color, absorbing all others; the second through a screen that absorbs all but the red-orange. Suppose you are photographing a red and blue dress. The red parts "take" only on the

(*Continued on page 114*)

Novelties of the Moment Told in Photographs

Skating across U. S.

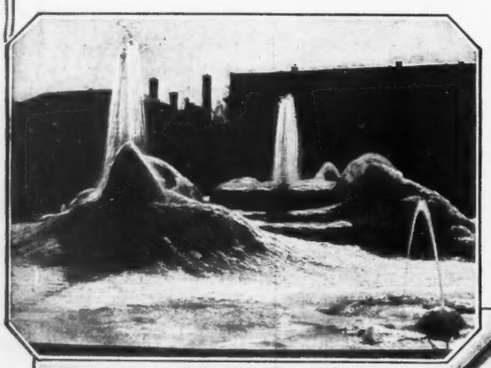
Earning their way by "stunt" performances in towns through which they pass, this happy-go-lucky couple, Mr. and Mrs. Fred Carson, of Philadelphia, Pa., are roller skating across the United States and back. They started from Philadelphia in May, 1921, and nobody knows when they will finish. Their route is to Seattle, Wash., then south to San Diego, and home again through the Southern states



At a "blind" hole, the periscope is now solving a difficult problem for the golfer who can't see the flag on the next green. By peering into this 20-foot tube, he can find out whether "all's clear"

Hanging by His Soles

Demonstrating the remarkable strength of a magnetic pulley, six of these men, whose combined weight is about 1000 pounds, hung from an iron bar in contact with the pulley. For the seventh man, hanging head downward, the only support was the attraction of the pulley for the iron nails in his shoes! The pulley was magnetized to attract small particles of iron from heavy loads of conveyed material

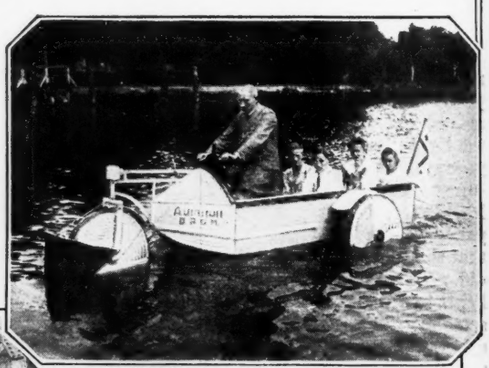


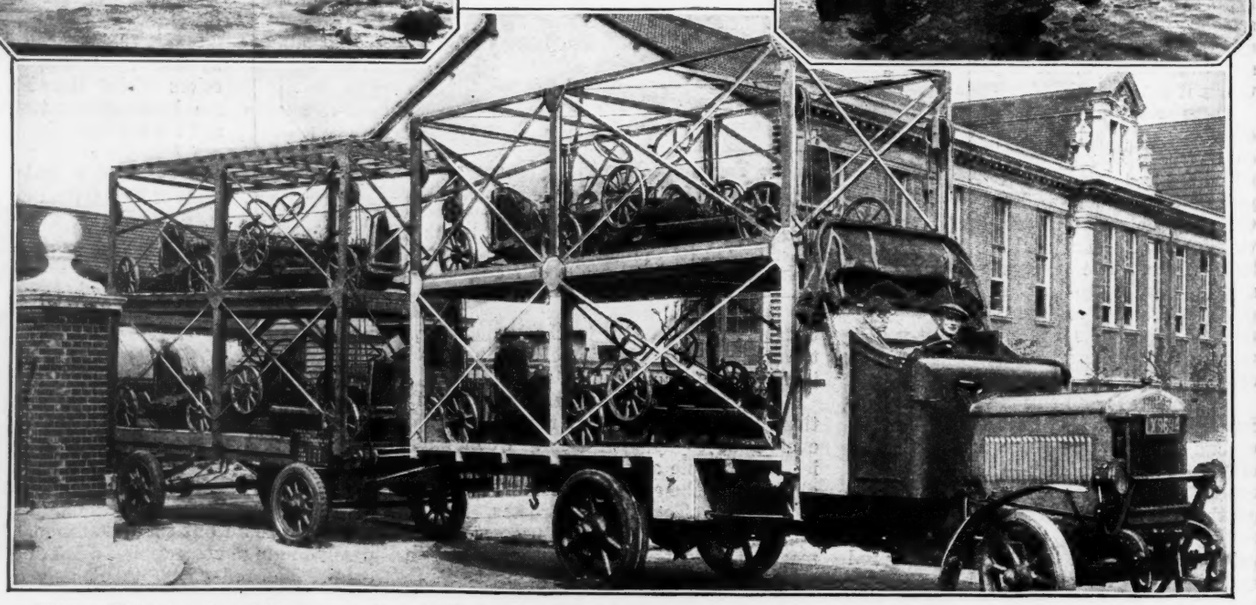
Icebergs in City Park

Perpetual fountains in Logan Square, Philadelphia, convert the square into a sparkling iceberg in winter, as shown at the left

Cycling on Water

The five-passenger "bike" (at right) travels on land or water. In the water the front wheel acts as a rudder. The rear wheels operate paddles





How a British automobile manufacturer delivers eight auto chassis to the body builders in one haul. Four of the chassis are carried on a two-story steel framework structure on the truck, the remaining four on a trailer

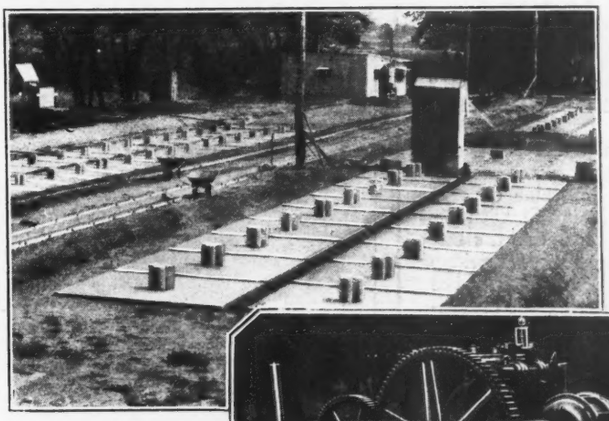
This Alarm Clock Jogs the Busy Man's Memory

SERVING as a memory jogger for the business man, a reminder clock, recently perfected, rings an alarm when the hour for an appointment arrives.

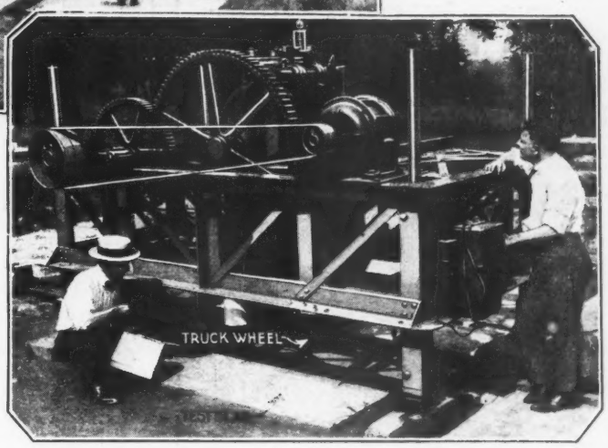
The rim of the dial has 48 slots into which small cards can be inserted. Each of these slots with card inserted, controls the alarms for a quarter-hour interval. Thus, should a reminder be required for 3.15, the card is inserted in the first slot between three and four. At that time, the alarm will ring for eight minutes, or until the card is removed.

As a further reminder of the purpose of the call, notations may be made on the card. Such notations would permit several persons to use the clock.

Road Tester Drops Heavy Truck Wheels



Effects of the impact of a truck wheel raised and dropped on concrete slabs by the electrical road testing machine shown below are registered on recording devices. For a further test, cylindrical concrete blocks, cured with the slabs as shown at left, are compressed to destruction



BY REPEATEDLY dropping a typical truck wheel to the pavement from any desired height, a new portable electric road-impact machine, now used by the United States Department of Agriculture to test concrete slabs, subjects the concrete in a few hours to wear and tear as great as that produced by driving a truck over a pavement for months.

The truck wheel is alternately raised and dropped by means of an electrically driven cam. Recording devices measure the rate at which the wheel is brought to rest after contact with the slab, deflection of the slab at a number of points on a line across it, settlement of the slab into the subgrade, the permanent set of the slab, and the maximum fiber stress at the point at which the blow is struck.

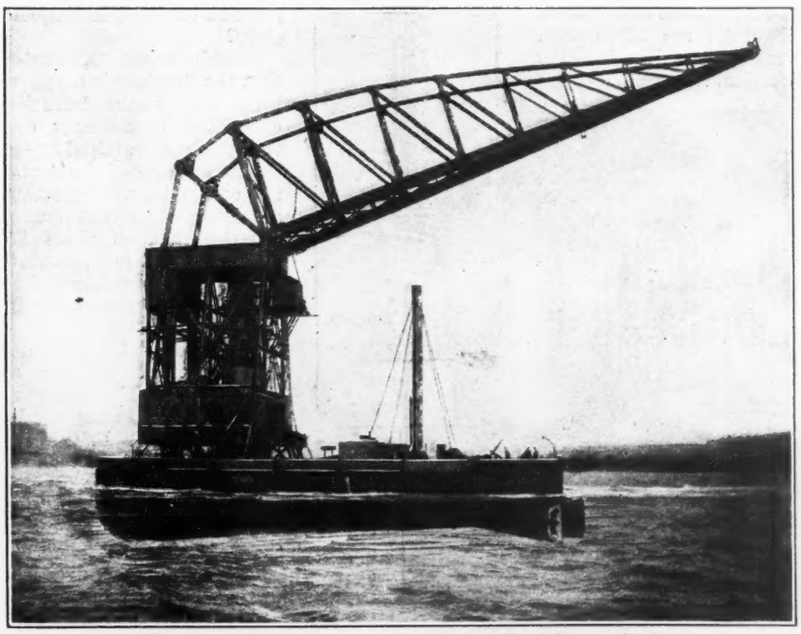
Small cylindrical blocks, made of the same concrete and cured on the slab, are used to determine the compressive qualities of the slab. These blocks are placed in a machine when cured, and are then compressed to destruction.

Giant Floating Crane Propels Itself

A MAMMOTH self-propelled floating crane, capable of lifting loads of 150 tons, is the recent contribution to the list of giant engineering equipments, by a Dutch engineer and shipbuilder, Mr. Werf Gusto.

The crane, of the derrick type, is provided with two sets of tackle, from each of which loads can be deposited upon the deck of the hull on which the crane is supported. Traveling counterweights serve to keep the pontoon level when loads are being lifted.

A boiler located in the hold provides the power for propelling the craft as well as the generator that supplies power for the electric crane. The crane can be operated by one man.



The huge floating crane, showing hull and propeller

Motor Driven Rolling Pins Massage Body

AN ELECTRIC massage apparatus that enables the operator to massage the entire body of a patient in a few minutes consists of a series of eccentrically mounted rollers on a shaft driven by means of a chain from an electric motor.

The rotating of the shaft causes the eccentric rollers to knead the body over an area equal in width to the length of the shaft, or about 1½ feet.

THE Editor will be glad to supply, wherever possible, the names and addresses of manufacturers of devices mentioned in this issue.

New Oxygen Mask Designed for Rescue at Sea

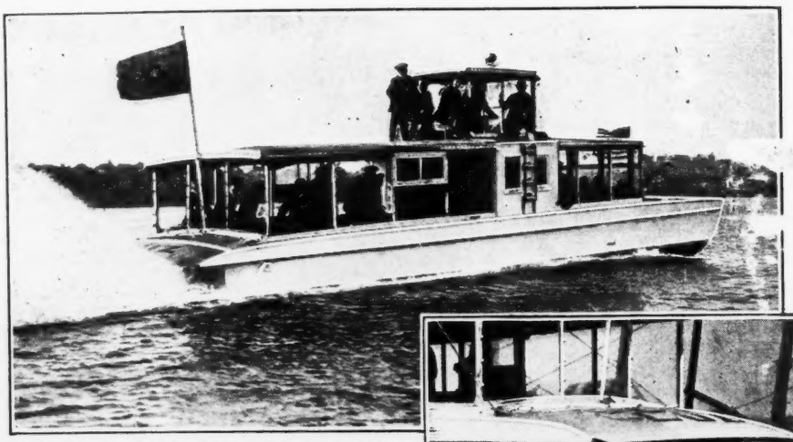
FURTHER development of the gas mask has resulted in a new breathing apparatus for rescue work, recently perfected for the navy by the United States Bureau of Mines.

The mask enables the wearer to remain under water for 15 minutes. It consists of a rubber breathing bag in which oxygen, escaping from a tank, is mixed with air from the outside. This air enters the bag through a canister or absorption cartridge which purifies it. Air discharged from the lungs escapes without entering the breathing bag.

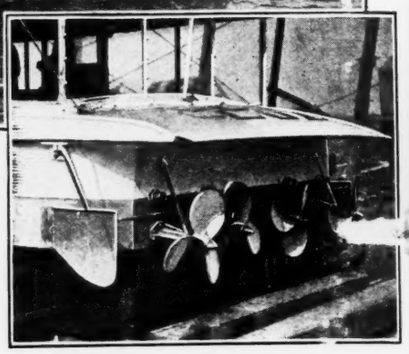
The apparatus will find ready use in mines and at fires.

In the breathing bag oxygen and outside air are mixed

Sea Sled Driven by Surface Propellers



Carrying a load of 51 passengers, this novel sea sled designed for shallow water transportation, recently skimmed over the Connecticut River at a speed of 30 miles an hour



At right: Drydock view of the stern showing four surface propellers and side plate rudders designed to eliminate water resistance

DRIVEN by four surface propellers, and designed to skim over the top of the water, a sea sled, built for use as a passenger boat on the Magdalena River, Colombia, S. A., recently developed a speed of 30 miles an hour carrying a load of 51 passengers up the Connecticut River.

The unusual craft is especially designed to operate in shallow waters. Its hull is shaped like an inverted V so that it glides over the surface of the water instead of plowing through it, this feature resulting in comparatively small loss of power from water resistance.

Since the propellers are at the surface, dragging of shafts and struts through the water, with consequent loss of power, is eliminated. In addition, there is little danger that the propellers will encounter the weeds of shallow waters.

Rudder at Each Side

Side plate rudders also offer little resistance to the speed of the boat, since they form a prolongation of the sides. They are so designed as not to be fouled or damaged by weeds or submerged obstructions.

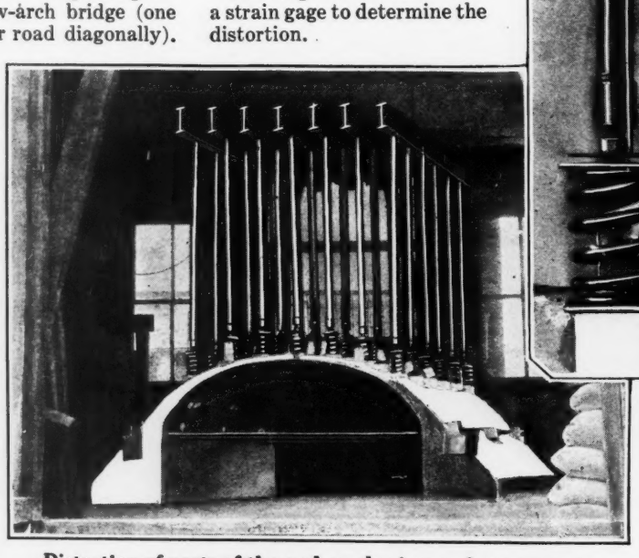
Skew Arch Tested to Destruction

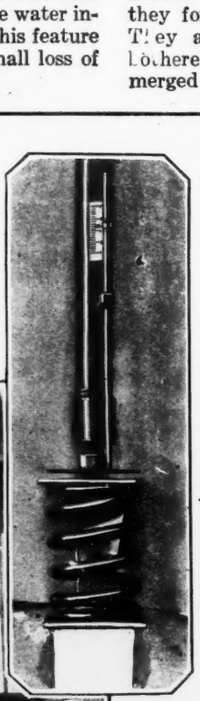
WHILE it has been comparatively simple for engineers to design economically an arched bridge to cross a stream at right angles, there has been considerable difference of opinion regarding the correct design of a skew-arch bridge (one that crosses a stream or road diagonally).

To obtain figures for such a design, engineers of the United States Bureau of Agriculture have constructed a skew arch one fourth the size of an actual bridge. This they are testing to destruction by increasing the load upon the top of the arch until it collapses.

The load is applied by downward pressure on spiral springs distributed over the top of the arch capable of carrying a load of 1500 pounds. Pressure is obtained by tightening screws located between the springs and vertical pipes braced against crossbeams above. The pressure on each spring is determined by measuring the distance it has been compressed.

Readings are taken with a strain gage to determine the distortion.





Distortion of parts of the arch under increasing pressure, exerted on springs above the arch, is measured by strain gages. Inset shows one of the springs with indicator to measure pressure

British Experimenters Defend Fireplaces

HAVE we been right in discarding the picturesque open fireplace as wasteful, inadequate and dirty?

British scientists, contending that the fireplace is not so wasteful as it may seem, have recently completed experiments showing that the best coal-fired grates give out 25 per cent of the heat of the fuel consumed, while gas fireplaces are nearly 50 per cent efficient and electrical heaters about 75 per cent. Radiant heat, moreover, is said to have certain physiological advantages over warm air from a heating apparatus.

Radiated heat travels directly through space without appreciably warming the air it traverses, although it heats any solid body it strikes. The British heating idea was explained by Prof. W. A. Bone, of the British Fuel Economy Committee:

"The more nearly conditions under which our living rooms are warmed and ventilated approach those of a warm summer's day—a cooling breeze blowing around our heads, the varying sunshine warming one side of the body, and the heated ground warming our feet—the more healthful our rooms will be; radiated heat creates these conditions."

Lifelike Glass Eyes that Pass for Real Ones

ONE person in every 300 wears a glass eye! When you consider that you may pass hundreds, or even thousands of persons a [illegible] without observing one [illegible] of sightlessness, this astonishing estimate, coming as it does from reliable manufacturers, is convincing evidence of the perfection reached by skilful modern artisans in duplicating the shape, size, and color of human eyes.

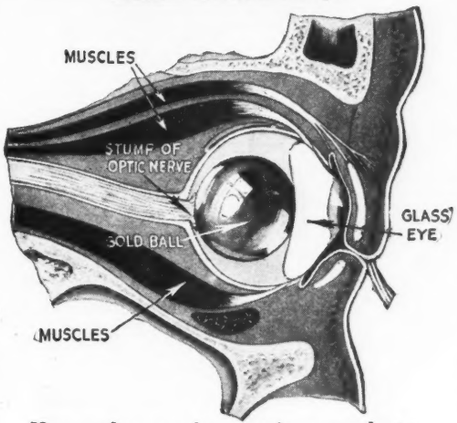
Blown from half-inch glass tubes, artificial eyes are "painted" by fusing colored glass into them. At left: Shaping an eye before a blowtorch. At right: Cutting a glass tube, that later will become an artificial eye

Working with colored glass "pigments" as a painter would work with his oils, these artisans not only match perfectly the sound eyes of their subjects, but actually have discovered a means of fitting an artificial eye over the nerve stump of a destroyed eye in such a way that the glass eye moves in almost perfect harmony with the subject's sound eye.

This degree of imitative skill, in many cases defying detection, has been developed through centuries of artificial eye-making. The ancient Egyptians wore golden eyes—made of hollow globes of gold, deftly enameled—while the Romans, as early as 500 B.C., pasted on their eyelids shallow earthenware cups, on which eyes were painted.

The modern artificial eye is formed from a long, hollow glass tube, about half an inch in diameter, tinted bluish white or yellowish white, to match the white of the patient's sound eye. On this glass, blown and shaped to form an eyeball, the iris and pupil are "painted" by fusing colored glass pigment.

First the artist heats one end of the tube over a blowtorch, and draws this end out to a long, narrow tube, which serves as an operating "handle." Next, he melts off a portion of the half-inch tube, sealing the end opposite the handle. Holding the handle, he softens this short cylinder in the hot flame. Then he blows through the handle, expanding the glass to form the eyeball.



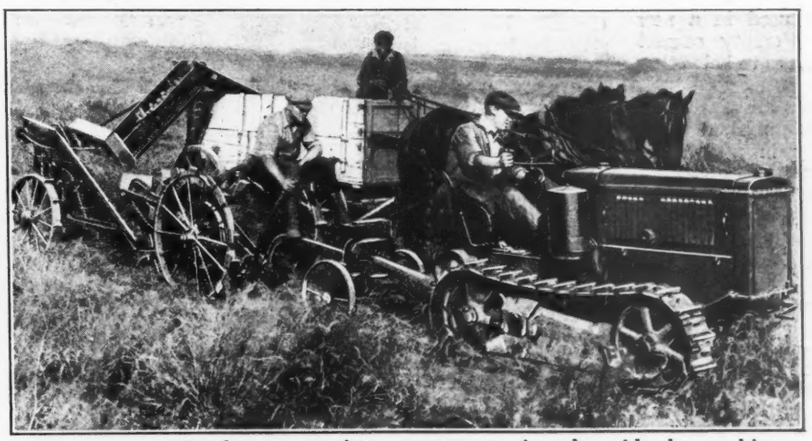
How a glass eye is sometimes made to move in harmony with the living eye. A gold ball, lodged on the optic nerve stump and held by the living muscles, forms a movable support for the eye

Now he begins the coloring process. From numerous sticks of colored glass on his worktable, the artist fuses into the glass eyeball colors and shades to match those in the good eye of his subject. To produce the mottled effect in the iris, for example, there are sticks of thinner rods of different colors, twisted and melted together. Similarly, the pupil is reproduced by melting black glass and fusing a small dab of it into the center of the iris.

Fully as marvelous as the manufacture of artificial eyes are the modern methods of fitting it so that it will move exactly like a normal eye. In modern operations, the stump of the optic nerve and muscles are retained wherever possible, so that the artificial eye will move in harmony with the patient's sound eye. Sometimes a gold ball is lodged on the eye stump, which forms a movable support.

Potato Digger and Loader Combined with Tractor

AFTER years of experiment by various manufacturers of farm implements, a combined potato digger and loader has been perfected in which a steel blade, passing under the tubers, lifts them upon a movable open slat conveyor. There the loose dirt and small potatoes are sifted out and the valuable potatoes are carried to a wagon that moves alongside of the machine.

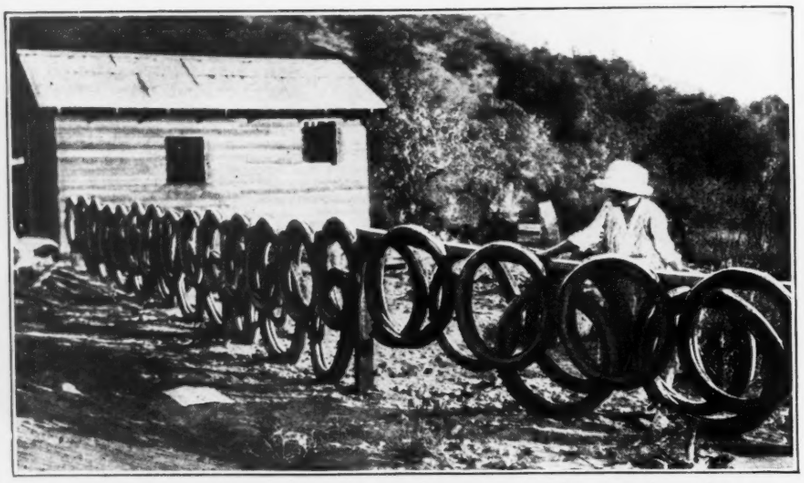


A conveyor carries the potatoes into a wagon moving alongside the machine

The outfit saves considerable time for the farmer, for the usual task of hand picking in the wake of a potato digger is a tedious one requiring many hands and consequently much expense.

A tractor is used to haul the machine along the rows as well as to supply the power required to operate the conveyor elevator. This power is transmitted through a shaft from the motor.

Fence of Old Tires Advertises Garage



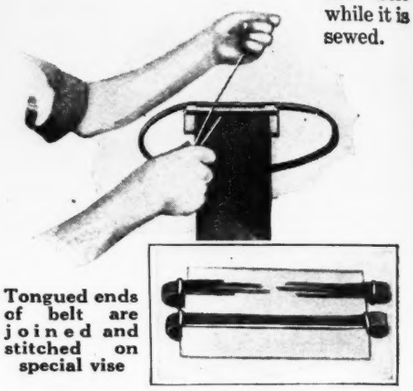
SERVICE and clever advertising are combined in a fence built on the premises of a garage near Glendale, Calif. The enterprising owner has used worn-out tires for this unique barrier.

The tires are nailed to a horizontal bar supported by posts in such a way that they overlap, thus forming a complete barrier. The unique advertisement of the garage's prosperity has attracted the attention of hundreds of passing automobile tourists to the garage.

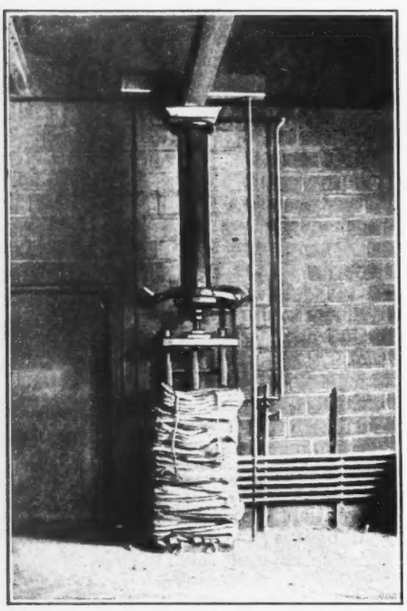
Ingenious Splice Lasts as Long as Belting

WITH stitches concealed so that they are not exposed to direct contact with pulleys, a belt splice recently patented makes it possible to join small belting, such as is used on an auto fan, so that the splice lasts.

The belting is cut so that one end will have tongues of unequal length that exactly fit into slits cut in the other end. Joined in this manner, the ends are sewed and the stitches are sunk into grooves on the edges of the belting. A special apparatus holds the belt while it is sewed.



Tongued ends of belt are joined and stitched on special vise



Compressed Air Ram Used for Baling Sacks

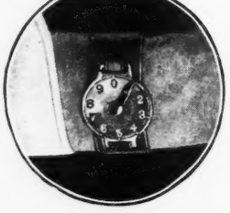
COMPRESSED air is used in a new apparatus for baling empty cement bags. The device also serves to bale other materials.

A hundred or more bags are placed beneath the ram, a lever is pulled, and the bags are instantly ready in a compact package.

Cords for tying are put in place before compressing the bags and are tightly tied before pressure is released. The ram is said to effect a distinct saving.

WHAT do you want to know? The Information Department of POPULAR SCIENCE MONTHLY will gladly answer every reasonable question on scientific subjects. Inclose self-addressed, stamped envelope with each inquiry.

Golf Stroke Counter Eliminates Errors



A "STROKE counter" has recently been placed on the market for the convenience of golf players who find it difficult to keep mental track of the number of strokes they require to make a hole. In match games an official scorer is provided, but even then a player likes to keep his own record. In his interest in the game he is likely to forget his count, and as he neither wishes to cheat his opponent nor himself, the uncertainty often unfavorably influences his game.

The stroke counter, designed to obviate these difficulties, consists of a small snap counter attached to a neat leather strap that is fastened around the wrist of the player. After each stroke the indicator of the counter is moved forward one notch and a distinct click informs the player that the stroke has been registered.

The weight of the counter is insignificant and does not interfere with free wrist movement in swinging a club.

Celluloid Plates for Sign Printing

TRADESMEN can save money by printing their own display signs artistically and rapidly with the aid of a new lettering outfit manufactured by a concern in Westport, Conn. No special skill in lettering is required to use the device.

The apparatus consists of 30 frames, each having a different type of lettering. The frame supports a transparent celluloid plate upon which letters have been impressed. A buffer is covered with carbon from a pad and then rubbed over the raised letters on the under side of the plate.

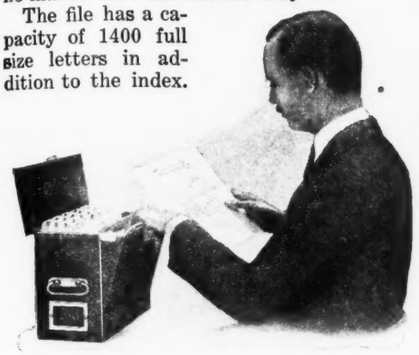
By placing the plate in position and running a pencil over the grooves of the upper surface of the desired letter, the carbon is impressed on the sheet below.

The under side of each letter plate is covered with carbon. Letters are impressed by running a pencil over outlines

Personal Filing Cabinet Is Easily Transported

A PERSONAL filing cabinet recently placed on the market by a New York manufacturer, weighs only 72 ounces without the index, but being of rolled steel, it is fireproof and can stand such abuse as it would receive in transportation. The drop front makes easy the removal of any paper, no matter how full the file may be.

The file has a capacity of 1400 full size letters in addition to the index.



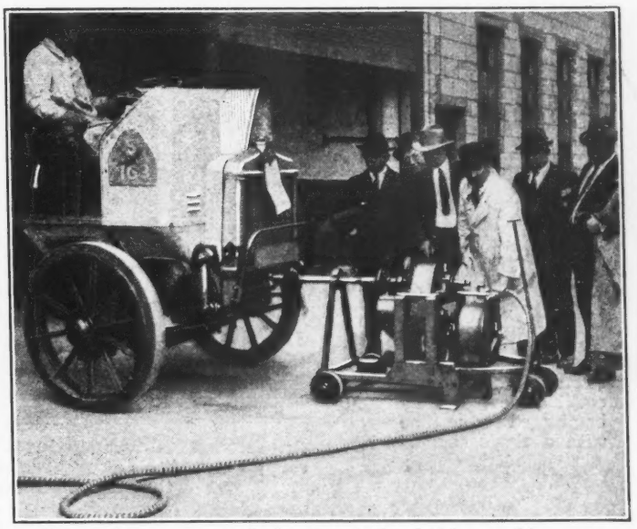
U. S. Needs Rare Metals

AN ATTEMPT is now being made by the government to discover new sources of platinum, nickel, tin, vanadium, tungsten, cobalt, antimony, chromite, and zirconium—minerals that exist in this country only in inadequate amounts or are entirely lacking. The metals experiment station of the Bureau of Mines at Reno, Nev., has undertaken to examine all samples sent to it. In a recent month 87 samples from 10 states were examined and 23 contained elements or compounds of value, including bismuth, mercury, nickel, platinum, uranium, vanadium, and grahamite.

Known geological conditions make it doubtful whether any of these metals will be found here to any great extent.

Cranking Machine Starts Balky Trucks

DIFFICULTIES of cranking the balky engine of a motor truck, especially in cold weather, may be overcome by the use of a newly invented cranking machine driven by compressed air and mounted on a small truck.



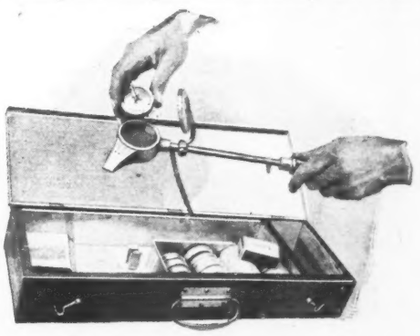
Driven by compressed air, the shaft of this cranking machine engages the crankshaft of the truck by a clutch

The drive shaft of the machine, with universal joint, engages the crankshaft of the truck by means of a clutch. Compressed air is fed into the machine through a flexible tube from a pressure tank. When the engine is started, the clutch is automatically released and the flow of compressed air shut off.

This starting machine was developed from machines that came into use at many aviation fields in Europe and America during the war to facilitate the starting of airplane engines, and was later applied to commercial use.

This Soldering Iron Is Self Heating

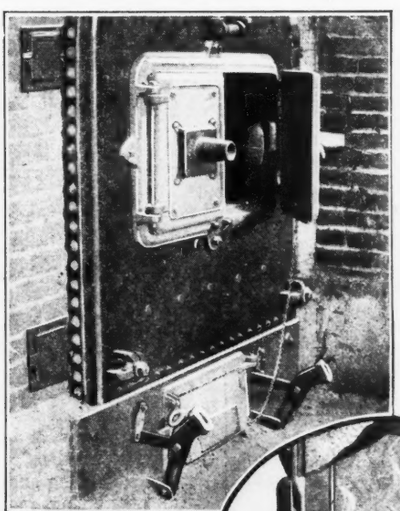
A SELF heating soldering iron, recently brought to this country, has a receptacle with a hinged cover into which a capsule containing a combustible material is placed. A special match is inserted in the top of this capsule or briquet and the wooden part of the match is broken off. The cover is then closed, leaving the long head of the match protruding through an opening in the cover. Another special match is used to light this head and an intense white heat follows instantly, consuming the briquet and heating the iron throughout. A single briquet will maintain the iron at soldering heat for about ten minutes. If a longer job is to be done, a new charge is put in.

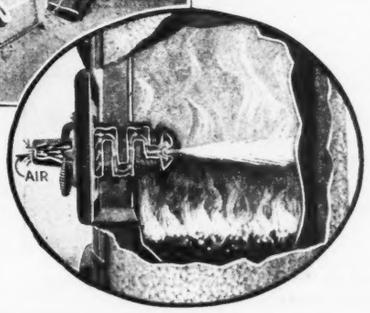


A combustible briquet, inserted into soldering iron, supplies the heat

The iron, briquet, and matches come in a metal lined box.

Blast Furnace Air Preheater Saves Coal





Drawn by the furnace draft through a winding passage, as shown at right, air is preheated for more perfect combustion

AN AIR preheater for house furnaces that utilizes the principle of the blast furnace and thereby, it is claimed, provides a fuel saving of at least 20 per cent, is being marketed by a concern in Richmond, Ind.

It has been proved that the greatest heat in a furnace is in the coal bed. This heat causes dissociation of the coal elements, many passing unconsumed up the flue because air necessary for combustion cannot mix with them.

The new attachment was designed to correct this by drawing in air through the upper door, so that the oxygen of the air can mix with unburned combustible gases that are distilled off. In order that the air may more readily combine with these gases, it is first preheated by passing it through a winding passage, the walls of which are subjected to the heat of the flames in the furnace. The natural draft of the furnace draws the air through the attachment.

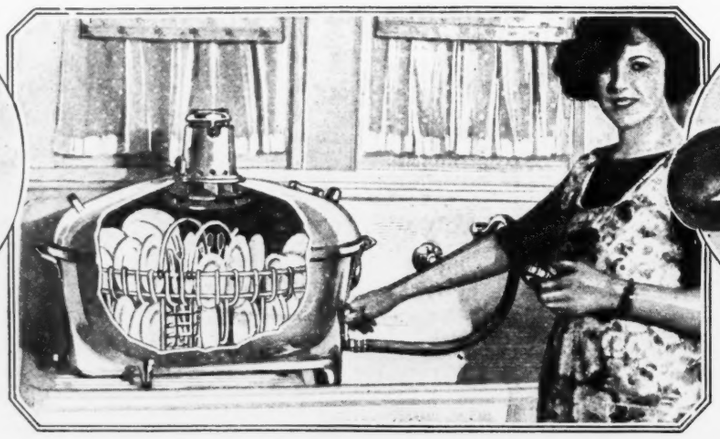
Sandy Loams Fight Frost

THE truck farmer who selects soil in which there is a sandy component, is in less danger of damaging frosts than if he has loam or clay soil, according to the U. S. Weather Bureau. Moreover, if he keeps his land well drained of surplus moisture and free from weeds, he is less liable to the damaging effects of severe temperatures.

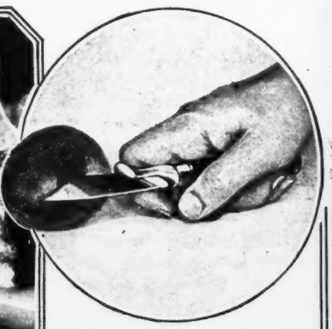
Experiments show there is a relation between the temperature of soil and the minimum temperature of the air, in that sandy soils store up much heat during the day and give this off at night, raising the temperature of the air above it.

Handy New Tools for the Housewife's Workshop

To this portable double socket for table use, two electrical heating or cooking devices may be plugged at one time with a single connection with light socket



An electrically driven suction fan pumps air through the hot, soapy water of this dish washer, agitating the water violently so that the dishes are thoroughly cleaned



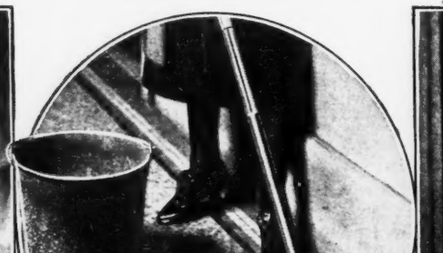
This kitchen paring knife has an aluminum guard curved to fit the second joint of the index finger and attached near the handle

For kitchen use, this axlike chopper has double blades, one with a sharp edge, the other with sharp cutting teeth

Built of ornamental silver lattice in lazy-tong fashion this dish holder can be made to fit any glass baking dish, round or oval

The double-hinged cover of this sink strainer may be swung under the strainer as a dripping tray for emptying contents

This small sewing machine lamp, when clamped to the arm of the machine, can be turned so as to throw its light on the work wherever needed



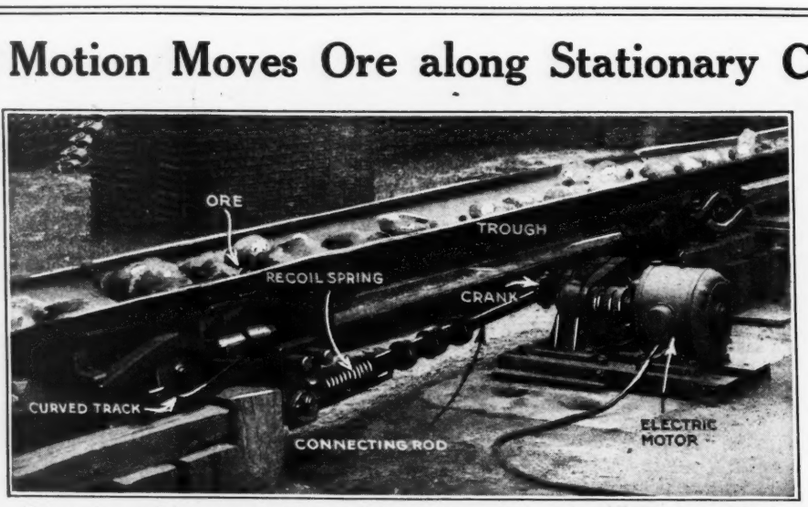
To wring this mop, raise the ring grip from the bottom, then turn the grip

This cellar door switch turns on the electric light in the cellar when the cellar door is opened and turns it off when the door is closed again

Shaking Motion Moves Ore along Stationary Conveyor

AN ELECTRICALLY driven stationary ore conveyor, that carries the ore forward by a shaking motion, consists of a metal trough operated by an electric motor. In addition, an upward motion is imparted by a curved track on which the trough rides. Thus, while the motor drives the trough forward by means of a connecting rod, the upward curvature of the track causes the contents of the trough to shoot forward and upward at the velocity of the trough.

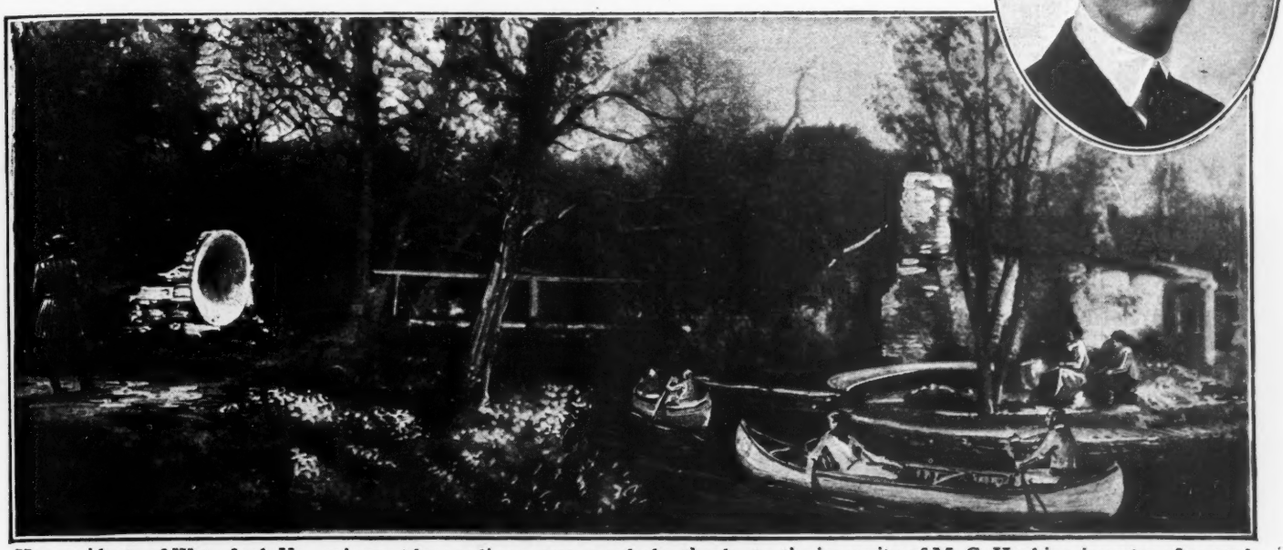
The forward motion is then suddenly arrested by a powerful spring and the connecting rod carries the trough back. Meanwhile the ore has been given sufficient momentum so that it continues to move forward while the motor executes its return stroke.



Driven forward by a connecting rod from the motor, and upward by a curved track, the conveyor trough is suddenly arrested by a coilspring and thrust back to its original position. This shaking motion shoots the ore forward

Better Days Ahead for the Loudspeaker

Using Cement Horn with Radio Amplifier, Inventor Floods Miles of Countryside with Melody, Giving Entire Rural Community Unique Entertainment



How residents of Waterford, Va., enjoy outdoor radio concerts regularly, thanks to the ingenuity of M. C. Hopkins, inventor of a novel loudspeaker that makes music audible nearly three miles away. Armstrong Perry, famous radio writer, is shown in inset above

By Armstrong Perry

YOU are driving your car along a country road in a prosperous farming community not far from a large city. Suddenly you hear a faint, barely audible melody floating through the air like the strains from some elfin orchestra.

At first you are startled. But as the music increases in volume, you believe it must come from some great-horned phonograph in one of the homes ahead on the road. Yet house after house is passed and the source of the music still seems far ahead. After driving nearly three miles beyond the point where the music was first audible, you come to a charming scene on the outskirts of a small village.

An Idyllic Community Center

In the corner of a well kept lawn beside a stone lodge surrounded by fish ponds, luxuriant shrubbery, and shaded benches built for two, stands a cement horn seven feet high and wide. The whole population of the village seems to be strolling past, lolling in canoes, or hanging over the low wall that borders the estate. And you are suddenly aware of the mysterious source of the music. Radio and the loudspeaker have combined to flood an entire countryside with melody!

This is not a dream, but a straightforward account of what actually happened to me last summer during a visit to the little Virginia village of Waterford, not far from Washington. There I discovered the veritable apotheosis of the loudspeaker. No less grandiose word expresses the impression I received. I have never witnessed a more satisfactory community gathering. It combined the generosity of a prominent citizen, the appreciative response of townspeople, the thrill of novelty, and intense scientific interest.

Curious, I interviewed the presiding genius of this community radio function. I found him to be none other than M. C. Hopkins, a man whose varied career has led him into music, into the profession of patent attorney, and into the realms of invention, where he was associated with Edison, Alexander Graham Bell, and a score of other scientists. Becoming interested in radio, he consulted with his friend, E. H. Armstrong, the radio wizard, and then went to work in hopes of solving the loudspeaker problem. What I heard on the lawn was the result of his efforts.

Hopkins explained to me that to eliminate certain difficulties he had designed a pick-up or transmitter to take the place of a microphone at the broadcasting station. The elimination of atmospheric interference, and tube noises had been accomplished as far as is possible at present by careful installation and operation of receiving outfits. In addition he tried to design his loudspeaker scientifically both in shape of chambers and horn and in the electrical apparatus and diaphragm that do the amplifying. And he believes that he has demonstrated that sound will travel extraordinary distances, *if the form of the wave is maintained.*

But even Hopkins is not entirely satisfied with results he has obtained. And, until more satisfactory loudspeakers are perfected, the average man must make the best of what is on the market. Substantial progress has been made of late, despite the difficulties involved.

There are two general types of loudspeakers. Simpler ones are horns with devices that make it possible to attach telephone receivers to the small ends. These horns use no energy except that which is delivered from the telephone diaphragm. Some are artistic, some were designed by persons having a knowledge of acoustics; and some are neither. The only way to pick a good one is to have your dealer give you a demonstration of each one.

If made faultily, so that it will vibrate, a horn will produce an unpleasant "blare" in harmony when the note turned into it is caused by vibrations having a frequency the same as its own. The perfect horn is one that will not vibrate, that preserves the "form" of the sound wave it transmits, and permits the sound wave to reach every spot in front of the horn.

The other general type of loudspeaker has a diaphragm of its own that is actuated by electrical current from a local battery. The most popular device costs $150, employing complicated apparatus. The manufacturers of this instrument recently have placed on the market another loudspeaker, costing $55, that may be attached directly to the amplifier of any receiving set, eliminating the expensive power amplifier. Another instrument costs only $20.

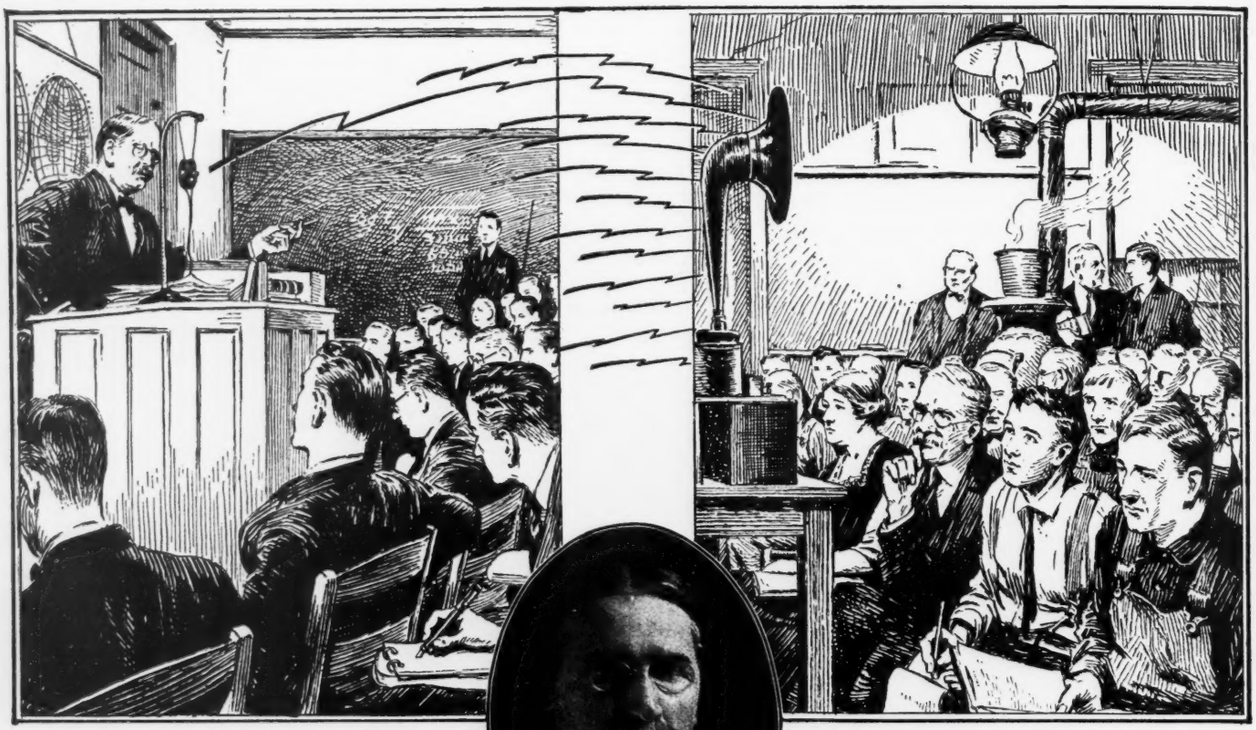
How the Phonograph Is Utilized

Several devices use a phonograph for the loudspeaker. The scientifically designed horn and connections of the phonograph make a good loudspeaker, but results depend entirely on the efficiency of the receiving apparatus. One device consists of a clamp to be slipped onto the arm or neck of the talking machine, a single phone being held in place by a screw. Still others use a Y-shaped attachment to which a pair of phones may be applied.

An interesting new device is attached beside the turntable of the phonograph, connected by wires with the radio receiver and the opposite poles of a six-volt battery. The phonograph needle is placed in a groove in a vibrating armature that protrudes through a slot in the middle of the device. Vibrations produced by the current received through the radio set are passed on to the needle so that sounds issue from the horn. When strong amplification was used, I found the music came through with phonograph quality, although with some distortion.

These, then, are the newer developments of loudspeakers. They are not entirely satisfactory, it is true, but there is every reason to believe that with more intelligent receiving and broadcasting, coupled with advances in invention that must surely be made, we may look for much better things in the near future.

Professor-Inventor Predicts "Radio Universities"



The "radio university" that Prof. Michael Pupin, of Columbia University, believes is sure to come with the further development of the loudspeaker. From the classroom where the university professor lectures to a group of his students—

Radio will carry a wealth of authoritative information and scientific knowledge to hundreds of town halls, factories, and firesides, offering a higher education to thousands of men and women to whom such training has hitherto been denied

Prof. Michael Pupin

Professor of physics; head of the Phoenix Research Laboratory at Columbia University, and inventor of the Pupin coil, which made possible transcontinental telephony

A COLLEGE education for every one who wants it.

A university in the home, in the factory and mill, and in the public hall.

An "aerial soapbox" for the forces of economic progress and right.

A complete course in practically any of the subjects now named in the college curriculum—for five dollars; an elementary course in these subjects for one dollar, and a single, far-reaching lecture on one of them by a worldwide authority for *ten cents*.

Vitally necessary education for the poor, the working man, and even the convict.

In other words, "The Radio Extension University."

"THESE are achievements I see directly ahead, and but one thing stands in the way of their actual accomplishment—the perfection of the loudspeaker," says Prof. Michael Pupin, in an exclusive interview with POPULAR SCIENCE MONTHLY. "When that day comes, Columbia University will be ready to prepare a carefully planned program for the Radio Extension University.

"Months ago, when the full significance of radio dawned on a surprised world, there formed in my mind a vague idea of what radio might some day mean to a university. Today, with radio broadcasting far advanced, that dream has become an almost certain future accomplishment.

"Here is the 'Radio Extension University' as I picture it:

"First, a great university like Columbia, equipped with a powerful broadcasting station for distributing to a knowledge-hungry people some of the vast store of authoritative information and knowledge accumulated by its great professors and teachers. Surrounding the university, within a radius of 100 miles, are scores of halls and public meeting places, each equipped with a radio receiving set and a powerful loudspeaker capable of amplifying voices without distortion.

"At the university broadcasting station an internationally famous professor, in his classroom, is delivering a lecture on some fascinating new chapter of, say, natural science. Simultaneously, in a hundred distant meeting places, crowds not unlike those at our theaters or public concerts are gathered before the loudspeakers, listening. Each person in the halls has paid 10 cents for the privilege, first of hearing the lecture by radio, then of submitting answers in a written examination covering the rudiments of the subject on which the broadcasted lecture is delivered.

"In each of the 100 halls 1000 persons—100,000 persons in all—are receiving an education without even leaving the limits of their own neighborhoods!

"Such a picture represents, to my mind, what radio may mean soon as a broadcaster of useful knowledge and as a disseminator of vital information.

"Go a step further. Enter a factory or mill of the future. It is lunchtime and, having finished their noonday meal, workers are lounging about on benches in an assembly room or one of the larger rooms of the factory. Some have pencils in their hands and are busily taking notes, while from the horn of a radio loudspeaker the voice of a university professor is carrying to them the higher education that has been denied them.

College Education for Convicts

"Another picture: Sing Sing prison, with its bare interior lighted up by huge arc lamps. In the cells around the courtyard, convicts seated on their bunks are listening intently to the radio report from some far-off university coming to their ears through the medium of a loudspeaker.

"Just one more picture and you will have grasped the significance of the plan for a radio extension university. Here is a home in which an ingenious youth has installed a homemade radio outfit with a loudspeaker. The entire family is listening as the lecture comes in, while the youth takes notes so that later he may pass a written examination on questions mailed to him from the university.

"As I have said, these are real possibilities, not dreams, as soon as the loudspeaker is perfected, and I think that day is near."

Western University Broadcasts History

AN IMPORTANT step toward accomplishment of the Radio Extension University, as predicted in the accompanying interview by Professor Michael Pupin, of Columbia University, already has been taken by the University of Washington, Seattle, Wash., where lectures in history have been successfully broadcasted, despite the shortcomings of the loudspeaker.

Jack Binns' Ten Radio Commandments

Fourth Series: Two Big Problems of the Moment—The Loudspeaker and Radio Frequency

Jack Binns

By Jack Binns

THE long-distance bug has bitten the radio fan, inoculating him with the desire to hear what the broadcasting stations across the continent have to say.

How can this long distance be achieved? Undoubtedly the best way is by the use of radio frequency amplification, and it is my purpose this month to guide the radio fan in its use.

Briefly stated, radio frequency amplification consists of building up the very weak currents received on an aerial, so that signals that normally could not be heard, are easily reproduced in the receiver. However, radio frequency amplification alone does not give volume in a loudspeaker. That can be obtained only by means of audio frequency amplification. In this connection it may be well to state a few pertinent facts regarding loudspeakers.

1. Know Your Loudspeaker

THE ideal loudspeaker has not yet been developed; but a few types on the market give admirable results when handled properly. These instruments fall in two general classes—those using auxiliary current, known as "electrodynamic loudspeakers," and those that merely employ sensitive phone receivers attached to the horn, perhaps the more popular method.

In using the phone receiver loudspeaker, bear in mind that if the current from the receiver is passed through the magnet coils of the loudspeaker in the wrong direction, they will become demagnetized, reducing the efficiency of the instrument. It is important, therefore, to determine the polarity of the coils as well as of ordinary head telephones. Many manufacturers are now marking telephone cords so that no mistake can be made.

If, by mistake, the speaker is wrongly connected and its magnet demagnetized, the situation may be remedied by carefully reversing leads to the receiver and then passing more than the usual amount of current for a considerable time until molecules of the iron magnet rearrange themselves and reconvert the metal back to a permanent magnet. A loudspeaker will not function properly unless the output of the radio receiver is of good quality; hence tuning is of prime importance.

2. Know Your Radio Transformer

YOU will be able to get the best out of radio and audio transformers by understanding their separate functions. The radio transformer deals with currents oscillating at frequencies far above human hearing; the audio transformer works on currents pulsating at frequencies that correspond to the range of vibrations audible to the average person.

Both types of transformers consist of two coils of wire, one called the "primary" and the other the "secondary." The secondary coils of the audio transformer may have from three to 11 times as many turns of wire as the primary coils, the object being to obtain a step-up ratio between the two.

In the radio transformer, on the other hand, the primary and secondary coils have an equal number of turns, this being necessary because of the remarkable quality of resonance that is encountered at high frequencies. With this arrangement, the amplifying properties of the vacuum tube are used to produce the necessary amplification, because of the fact that a small current in the grid circuit releases a large current in the plate circuit. The vacuum tube, therefore, is an amplifier in itself.

So far as high frequencies are concerned, the problem in radio amplification is to transpose the output of one vacuum tube to the input circuit of the other. Although there are three ways in which this can be done, experience has taught us that the method that uses transformer coupling is the best on high frequencies.

Our radio transformer is really nothing more than a coupled, tuned circuit that is in resonance with a very narrow band of wave lengths, taking the output of one vacuum tube on its primary and—by reason of the inductive coupling between its windings—transferring this to the secondary, which, in turn, impresses the current onto the grid of the next tube. Thus the radio transformer is a means of transporting the amplified result of one tube to the next tube for further amplification.

For successful operation of the radio frequency amplifying receivers, the transformer should have these characteristics:

First, it should be completely shielded. Second, its coils should be wound in such a way that the capacity effect is at a minimum (reversal of the secondary leads sometimes produces this effect in badly designed transformers). Third, for the same reason, windings should be of as small a diameter as possible. Fourth, the number of turns should be just sufficient to produce the correct amount of inductance and capacity for the range of wave lengths for which the transformer is to be used.

3. Place Your Trust in Short Leads

JUST why should you avoid all unnecessary capacity in the use of radio frequency amplification? In explaining the reasons, let's consider the 360-meter wave length, since most of us are chiefly concerned with the reproduction of music and speech from broadcasting stations.

It is generally understood that there is a direct relationship between wave length and the frequencies of magnetic waves that surge through space. For a wave length of one meter, this relationship is 300,000,000 cycles a second; for a wave length of 3000 meters, it is 100,000 cycles a second. In other words, if we know the wave length, we can determine the frequency by dividing 300,000,000 by the wave length in meters. Thus, the 360-meter wave has a frequency of 833,333 cycles a second.

Now, to understand the importance of capacity in a circuit using the 833,333-cycle frequency, consider the nature of its action. If a condenser is joined in a circuit, and a direct current placed on the circuit, the moment the current is applied, a small charge will be placed on the condenser, after which further action will be stopped. Reversing the direction of the current will put an opposite charge on the condenser.

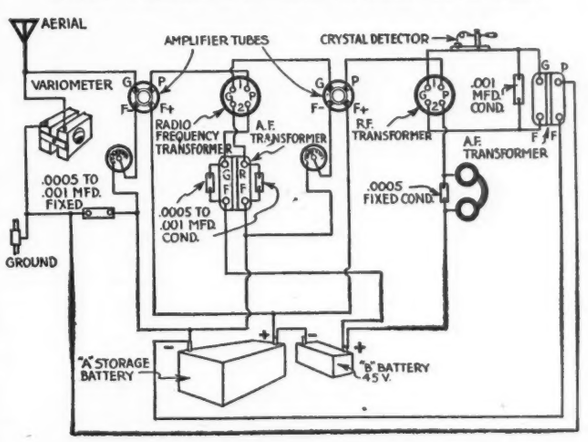
If we place an alternating current, instead of direct current, on the circuit where the condenser is used, this same charging and reversal will take place at the rate at which the current is alternating. In other words, with a 60-cycle current, there will be a current passage through the condenser 120 times every second, or once for every alternation. For currents corresponding to those used on the broadcasting wave lengths, where the frequency is 833,333 cycles a second, it will be readily seen how the condenser offers an easy path.

And, since two insulated wires close to each other act as a condenser, it is imperative that all connecting wires be kept as short as possible. Otherwise the capacity will be increased. This cannot be emphasized too strongly, especially in the leads from the tuner to the vacuum tubes and the wires connected with the tube grids.

4. Make Tuning Elements Simple

IN RADIO frequency amplification you are using what is practically a tuned circuit between each tube, and to an extent this is equivalent to a multiple tuned

Two Tubes Do the Work of Four



IN THIS so-called reflex action circuit, amplifying tubes perform a double function, acting as both radio frequency and audio frequency amplifiers simultaneously. Thus it is necessary to use only two tubes for two stages of radio and two stages of audio frequency amplification, instead of the four usually required

Various Ways to Hook Up Your Radio Frequency Set

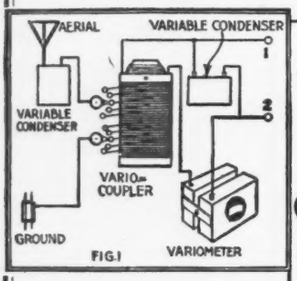


FIG. 1

The diagram above shows a variocoupler variometer tuning circuit that can be used with the three-stage amplifying circuit (at right). To use this tuner, connect terminals 1 and 2 with terminals 7 and 8 respectively in the radio amplifying circuit

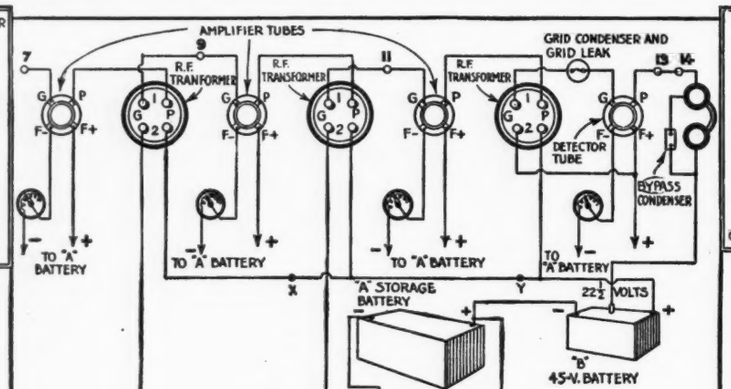


FIG. 4

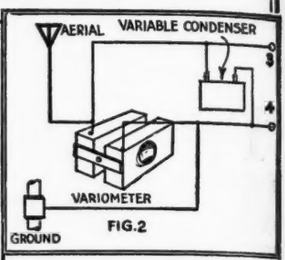


FIG. 2

The variometer tuning circuit above is another tuning element that can be used successfully with the radio frequency amplifying circuit at the left. Connect terminals 3 and 4 with terminals 7 and 8 respectively, in the radio amplifying circuit

circuit, because transformers will refuse a pathway to any wave length that does not come within their range. This, in conjunction with the necessity of keeping the capacity as low as possible, makes it absolutely imperative that only the simplest form of tuner should be used.

In cases where an aerial and ground are used in a radio frequency receiver, it is best to have a loose-coupled tuner to obtain the best selectivity and eliminate troublesome capacity effects. In my work recently with this form of amplification, my tuning element consisted solely of a short wave variometer in the aerial circuit with a half inch lead from the aerial side of the variometer to the grid of the first tube, and another lead of the same length from the ground side of the variometer to the center tap of the potentiometer. This arrangement, I found, gave me ample selectivity and great efficiency.

If you use a loop aerial with your radio frequency receiver, it is necessary to use a variable condenser in order to tune the loop to the wave length required. The condenser, however, should have as small a capacity as possible and leads to and from it should be as short as the set will permit.

For radio frequency amplification, elaborate tuning apparatus is entirely unnecessary. Rheostats are not necessary either for radio or audio frequency tubes, although a rheostat is needed for the detector. Thus the circuit is limited to three controls—the tuning element, the potentiometer, and the detector rheostat.

5. Trust the Potentiometer

IN RADIO frequency amplification the potentiometer, a variable resistance device, is the stabilizing element that keeps the entire set under control. The instrument consists of a fixed resistance placed squarely across the A battery. Its variable connection forms a third contact point with an arm that moves across the resistance, thus enabling the operator to take a voltage of any amount for use in the circuit with which it is connected.

In the case of radio frequency, this voltage is for the grid-filament circuit through the tuning coil connected with the radio frequency tube. The potentiometer permits us to put a voltage of any amount upon the grid of the radio frequency tube. This voltage may be but a few milli-volts.

Now to keep the entire set in a state of equilibrium it is necessary that the grids of the amplifying tubes be negative with respect to the filaments. The extent to which the grid is negative with respect to the filament depends upon conditions in the set and must be determined by adjustment. That adjustment is just what the potentiometer is for. Consequently, the adjustable arm of the potentiometer will be on the side of the resistance element in such a position as to put the negative bias on the grid. Louder signals are obtained when the arm is on the positive side of the resistance element, but more stable results are obtained from the negative side.

6. Use a Battery Switch

REMEMBER that because you are using a potentiometer across the A battery, you are slowly discharging the battery. If this arrangement is allowed to remain when the set is not actually in use, the battery will soon run down.

Use a battery switch, therefore, and disconnect the storage battery when the receiver is not being used.

7. Use a Loop wherever Possible

SINCE a loop aerial is highly directional in its effects, it serves as an excellent tuner, cutting out 50 per cent of interference. The loop will receive signals only when it is pointed in the direction of the broadcasting station to which you wish to listen. Stations located at right angles to the plane of the loop will be entirely eliminated.

For broadcasting reception the loop can consist of eight turns of No. 18 annunciator wire wound on a square frame three feet to a side. These turns should be carefully spaced one half inch from each other.

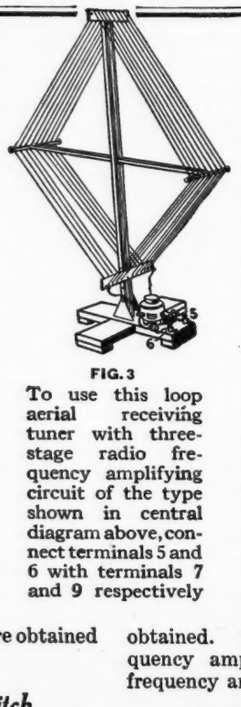


FIG. 3

To use this loop aerial receiving tuner with three-stage radio frequency amplifying circuit of the type shown in central diagram above, connect terminals 5 and 6 with terminals 7 and 9 respectively

8. Use Only Hard Tubes

A SOFT or detector tube cannot be used successfully as an amplifier, because it is decidedly critical as to voltages. At present there is no well designed tube for radio amplification. As a result, transformers have been designed for tubes on the market.

9. Transfer Tubes in the Circuit

ALTHOUGH vacuum tubes are now made in quantity from standard designs, no two are identical. In receivers employing more than one stage of radio frequency amplification, it will be found that reception will be greatly improved if the tubes are changed from one socket to another until the most effective combination is obtained. This holds true for audio frequency amplification as well as for radio frequency amplification.

10. Regeneration and Radio Amplification

MANY fans ask whether it is possible to add one or more stages of radio frequency amplification to their standard regenerative receivers. The answer is that such addition can be made, but that it is *not* advisable for these reasons:

First, because you should keep your radio frequency set as simple as possible. Second, because of the capacity coupling between the elements of the vacuum tubes, radio frequency amplification contains all the elements of regeneration in itself. The amplification obtained from three stages of radio frequency is so remarkable that no further addition should be necessary. It would be gilding the lily.

THIS three-stage radio frequency amplification circuit may be used with any of the three tuning elements shown in Figs. 1, 2, and 3. In using all three stages of amplification, connect the tuning element with terminals 7 and 8. For two stages, connect tuning element with terminals 9 and 10 and break the circuit at X. When only one stage of amplification is to be used, connect the tuning element with terminals 11 and 12 and break the circuit at Y.

The use of regeneration with this type of circuit is not advisable; but regeneration can be used by breaking the circuit between terminals 13 and 14 and connecting the leads of a variometer with the terminals

Why Tires Wear Out and How to Save Them

Important Facts about Tread and Fabric that Will Help You Cut the Cost of Driving Your Car in Winter

By Harold F. Blanchard

WINTER is the time when tires suffer most. Sharp pieces of ice cut and tear the tread, while icy ruts rip the side walls to shreds. Pieces of ice are picked up by the tire, and later, when the car is in a warm garage, the ice turns to water that rots the tire structure.

On snowy, slushy, and rainy winter days, tires are subjected continuously to the ravages of moisture, their arch enemy. Frozen roads or sharp stones cut holes in the tread through which moisture can reach the fabric underneath. Then rotting sets in, and as the holes grow larger, mud and perhaps some oil enter. Gradually the moisture, like so much acid, eats through layer after layer of fabric until a spot becomes so weakened that the tube blows out through it.

The first step in protecting tires against their winter enemies is to examine them frequently for cuts. Whenever a cut is found, it should be filled with a rubber compound. If the cut is very large, better take the tire off and have the hole vulcanized. Don't fit tire chains too tightly. Unless the chain has opportunity to slip, the cross links will wear the tread.

ALTHOUGH a tire is welded into a single piece, it is really a rather complicated structure, as the sectional drawing on this page clearly shows. If you expect to obtain low cost to the mile you must not only care for your tires properly, but you must have well built tires to start with. Beads must be strong to hold the tire on the rim. The cotton fibers must be sound, for the failure of even a few of them at one spot will eventually produce a blowout. The tread must be tough, while the layers of cushion gum of nearly pure rubber must be proportioned and tempered with care.

Once the tire structure is understood, it is not hard to realize just how, when, and why a tire can be abused. The most frequent form of neglect is to run it with too little air, which produces the same disastrous effect as overloading a tire that is not large enough for the weight it must support. Insufficient air bulges out the tire carcass so that at the point where the tire flattens over the rim, some of the fibers in the inner layer of fabric will stretch beyond their strength and break.

If the interior of the tire is examined, a slight fuzz will be observed along the inner surface. This means some broken fibers. Little by little, more fibers will break, until all the fibers in the inner layer are broken and a definite crack develops. Then the next layer will crack, and so on. Finally, one of two things will happen: The tube may be pinched in the crack and thus the tire will go flat, or the crack will develop until the last layer gives way, causing a blowout.

A cord tire is not so likely to be injured by underinflation as a fabric tire. When a fabric tire is flexed, the longitudinal threads are bent around the cross threads, and thus are greatly strained. This condition is eliminated in the cord tire because the threads in each layer of "fabric" lie flat and parallel. For the same reason friction also is less in the cord tire.

Friction generates heat, and if internal friction is excessive, the tire temperature may rise high enough gradually to vulcanize the rubber to a point where it will lose its strength. Then the layers of fabric will begin to separate, and in chafing against each other will wear and produce still greater heat, causing destruction of the tire.

The development of a blowout may be likened to breaking a flexible wire by bending it back and forth repeatedly. The blowout may start with the failure of a few small fibers at a certain point. Added strain thus is thrown on adjacent fibers, causing further breakage until some of the threads are severed. Then more threads break, and the fracture spreads through one layer of fabric to another, until the tire at this point

The Ten Parts of an Automobile Tire

1. Tread—A tough outer sheath of rubber compound built to withstand continuous contact with the road. Before vulcanizing, it is compounded with sulphur to give it hardness. Lampblack or zinc oxid is added to toughen it.

2. Breaker strip—A loosely woven piece of fabric resting on a thick layer of cushion gum. It distributes thrusts of sharp stones, etc., over a comparatively large area and thus protects the fabric underneath.

3. Side wall rubber—A rubber compound protecting sides of the tire.

4. Wire—Piano wire is usually employed in building the bead core.

5. Bead reinforcement—A layer of fabric wrapped around the triangular shaped bead. It strengthens the side walls just above the beads, where the tire receives the most bending.

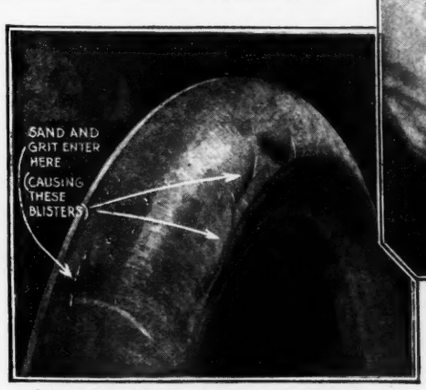
6. Bead core—Usually numerous piano wires embedded in rubber and fabric.

7. Beads—Tough rubber portions of the tire that come in contact with the rim.

8. Filler for bead core—A combination of rubber and fabric.

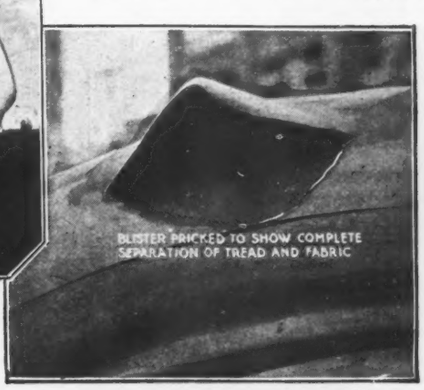
9. Carcass—The tire foundation laid in layers, either of cord or fabric, separated by cushion gum.

10. Cushion gum—Nearly pure rubber, soft and elastic; acts as a spring contact between the fabric carcass and the breaker strip on which the thread is mounted.



How a small neglected cut grows into a blister, then a blowout. Moisture, sand, and oil enter, separating tread from fabric and finally rotting fabric

Here's an easy and effective way to patch a tread cut. With a blunt tool force into the cut a piece of plastic rubber that you can purchase in convenient cartons. Then cut off the unused filler even with the tread. Careful attention to each small cut will prevent blisters like those shown in insets



To remove sand and grit from a blister, open the blister at the point farthest from the tread and scrape out the accumulation carefully

can no longer withstand the outward pressure of the tube and gives way.

A blowout may be started by any excessive strain such as running over a sharp stone, striking the edge of a curb, running tires too flat, or it may be caused by weakness in the carcass itself. Rotting of the fabric by moisture, dirt and oil is another common cause.

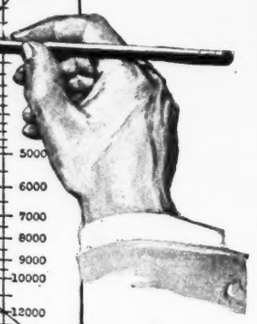
When the tire is built, its cotton structure is protected against the elements by a strong exterior of rubber. But in use, if a cut is deep enough to pierce the rubber, rotting will begin. The size and depth of the rotten spot gradually grows until it becomes so weak that the tube blows through. Sometimes the spot will spread entirely around the tire, loosening the tread as it goes, and rotting the outer layers of fabric underneath, with the result that when the tire finally does blow out, most of the tread is loose and the outer layers of fabric are completely destroyed.

How to Avoid Blowouts

The best ways to prevent such blowouts are these: First, avoid cutting objects such as glass and razor edge switch frogs by alert driving. Drive over sharp stones slowly. Avoid car tracks, and especially switches, as much as possible. Be doubly cautious in wet weather, because wet surfaces cut rubber more readily than dry surfaces. The tires should be examined occasionally for deep cuts and whenever one is found, it should be filled with some compound specially prepared for this purpose, or if the cut is very large or deep, it may be advisable to take the tire off and have it vulcanized. If the fabric underneath has not rotted, this repair will be a very simple one and should not cost more than a dollar.

When a tire blows out while the tread is still good, examine the carcass carefully. If there is extensive looseness of tread or fabric, or if there are incipient checks or cracks on the interior, areas of rotted fabric or rim cuts, it is usually best to discard the tire. You can detect loose or rotten fabric by feeling for a soft spot when the tire is off the wheel. To detect loose tread, grasp the beads in your hands and compress the tread with your thumbs.

If a tire is to give full satisfaction, every detail of its construction must be right; and that is the best reason for buying new tires of good quality; you never can be sure about "tire bargains" or "seconds." Usually there is something seriously wrong with a second, although the defect is rarely apparent. Its tread may be too hard or too soft, and defective in wearing quality, either because of the wrong amount of heat or wrong compounding of the rubber. A layer of fabric may have been accidentally left out or the tire may be mold pinched.



"New tires" that sell at "bargain prices"—say from three to five dollars—are usually junk tires made over. Blowouts have been hastily repaired, a thin layer of fabric has been added to the inside and a new tread placed on the outside. Frequently such treads are largely composed of pitch compounds with just enough rubber to give a rubber smell. These treads will not last more than 50 miles.

Retreaded tires don't pay. Their cost to the mile is rarely as low as that of good new tires. The chief objection to them is that the treads come loose, the carcasses are usually overcured if heat has been used to apply the treads, and finally, after the original treads have been worn off, the carcasses are rarely in much better shape than the treads.

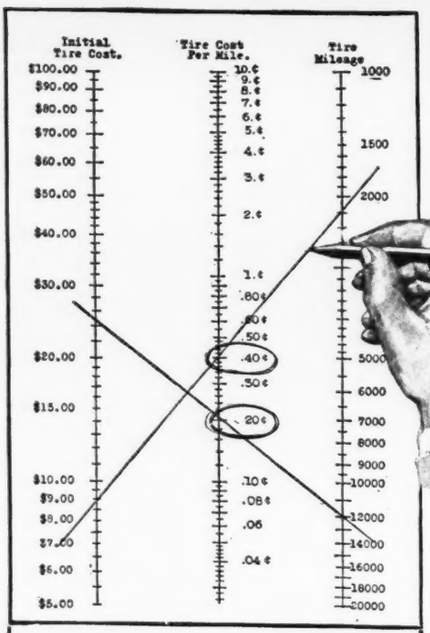
It pays not only to buy good tires, but it also pays to repair them carefully. Cold patches, while easy to apply, are uncertain, and they should be used only on a light car driven slowly. Usually it costs not more than 25 or 50 cents to have a punctured tube repaired by an expert tire man. Then you are reasonably certain that the job has been done correctly. If you prefer to do your own work, a small portable tube vulcanizer, costing a dollar, is far superior to a cold patch.

Protect the Tube

In repairing a straight-side tire, a canvas strip or flap should be inserted between the tube and the rim side of the shoe to protect the tube. Don't use a flap that is torn or frayed, for it is likely to pinch the tube. A large puncture hole should be covered with a small patch inside the shoe to prevent tube pinching.

Avoid skidding around corners, and be careful not to allow the brakes to lock the rear wheels. In just a few seconds of sliding, more rubber may be worn off a tire than in hundreds of miles of running. The brakes should be carefully equalized so that they will go on with equal force; otherwise one wheel may lock long before the brake acts appreciably on the opposite wheel.

(*Continued on page 75*)



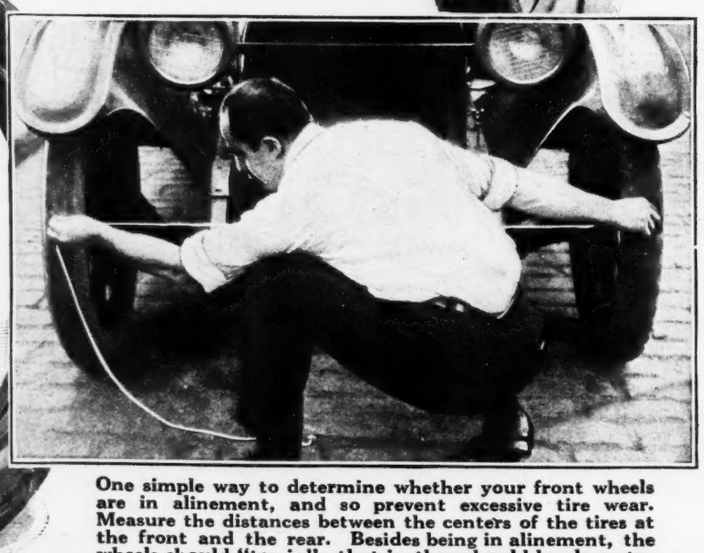
Why Well Built Tires Cost Less in the End

THIS chart shows how you can cut tire bills by buying first class tires. For example, a $9 tire, good for, say, 2200 miles, will cost you four tenths cent a mile, while a $25 tire, good for 12,000 miles with proper care, costs only two tenths cent a mile, or half as much as the $9 one.

Clip out this chart and use it to keep a record of what your tires cost you. From a point in the left hand column corresponding to the initial cost of your worn out tire, draw a line to the point in the right hand column corresponding to the total mileage of that tire. Where this line intersects the center line, read the cost to the mile

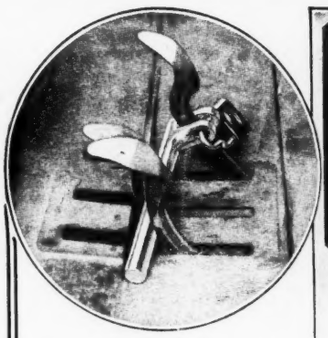
At right: What happens to a tire tread when wheels are out of alinement. Note the worn path clear around the circumference. This can be prevented as shown below

Running in frozen ruts and against curbing ruined this perfectly good tire. Note how the light rubber of the side walls has been broken by friction

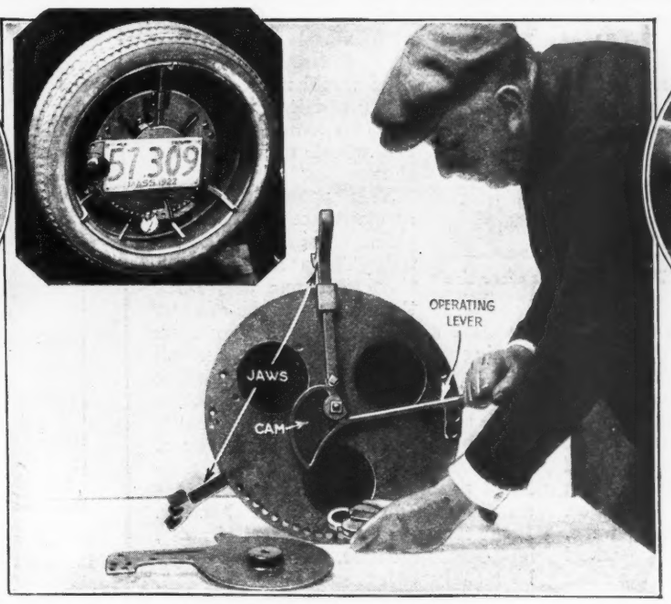


One simple way to determine whether your front wheels are in alinement, and so prevent excessive tire wear. Measure the distances between the centers of the tires at the front and the rear. Besides being in alinement, the wheels should "toe in"—that is, they should be closer together at the bottom than at the top

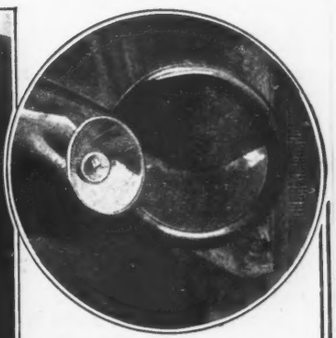
Theft-Proof Tire Holder—Other New Accessories



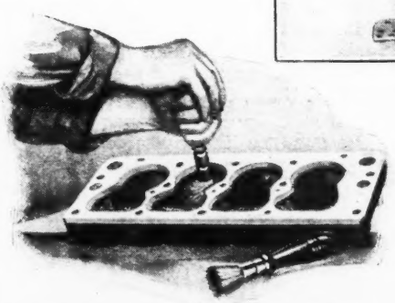
This safety lock for Ford cars consists of an iron bar slipped between the reverse and gear levers and locked to the brake



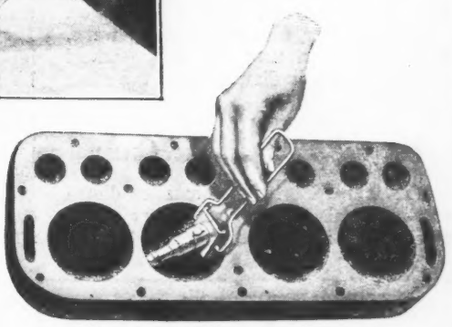
A new thief-proof tire holder consists of a disk with three radial sliding arms that push outward to engage the rims of the tires by a centrally pivoted lever with an eccentric cam. A series of holes along the rim of the disk make it possible to padlock the handle of the lever when the jaws have a firm hold on the tires



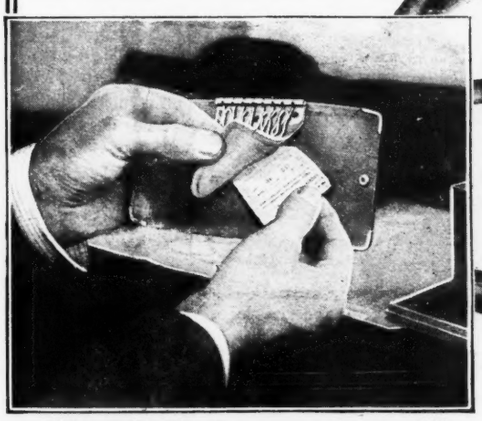
A combination lamp and reflector forms a unit that fits into the headlight socket without interfering with the dimmer



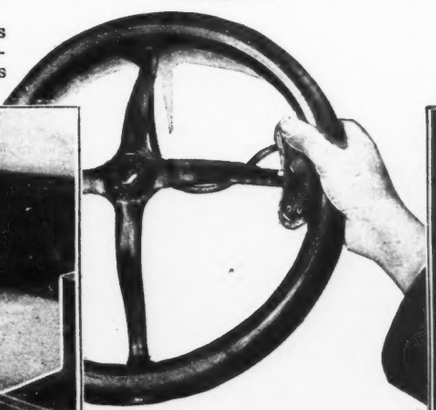
This carbon brush with wire bristles is a useful accessory for removing carbon deposits from corners and curves



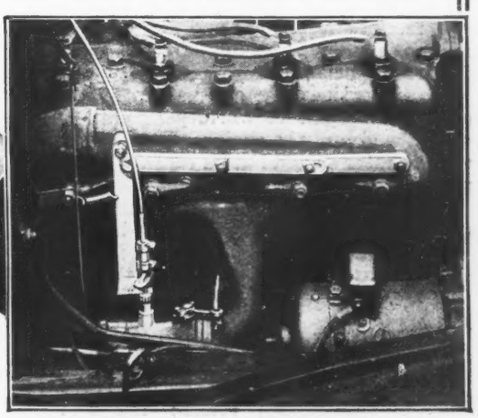
The method of using a recently invented gage for measuring the inside diameter of automobile engine cylinders is shown above



This combination key case and automobile license pocket recently placed in the market will hold from one to 16 keys



Pressing one end of this control lever starts the lights; pressing the other, dims the lights. The horn button is in the center



Installed on a Ford carburetor, this regulator modifies carburetor setting as temperature of the exhaust manifold changes

(*Continued from page 74*)

This condition is not only hard on tires, but dangerous. You will conserve your tires by using the brakes as little as possible. Reducing speed by coasting is better than braking, as you will learn by observation.

Intermittently slipping the wheels of your car by ascending a rough incline at full speed in second or low gear is very hard on tires as well as on the entire car mechanism.

Make sure that the front wheels are always in alinement, otherwise they will cause excessive tire wear. Springs that are too flexible or too stiff will cause additional tire wear.

Know Your Car

ONE way to know your car and run it economically is to have a good automobile reference book at hand.

Supplementing the regular articles in POPULAR SCIENCE MONTHLY, some of the best books, both for the average car owner and for the garage proprietor or mechanic, are the following:

The new (thirteenth) edition of Dyke's "Automobile and Gasoline Engine Encyclopedia" (Goodhardt-Wilcox Co., Chicago), which covers every phase of the construction, principle of operation, care and repair of automobiles, motor trucks, tractors, motorcycles, motor boat and stationary engines.

"The Modern Gasoline Automobile" and "Automobile Repairing Made Easy," both by Victor H. Page, and published by the Norman W. Henley Co., New York.

"The Gasoline Automobile," by Hobbs and Elliott, McGraw-Hill Book Co., New York.

Undersized tires are poor economy. On a certain car the tire mileage was increased from 5600 to 9600 by adding half an inch to the tire size.

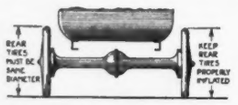
A new tire should always be equipped with a new tube—such a combination is likely to give 10,000 to 15,000 miles without any trouble, whereas a half worn tube gives out when least expected.

And most important, inflation of the tires should receive the most careful attention. Don't guess at their pressure, but use a tire gage. If you buy good tires, you can surely cut your tire bill in half by keeping them properly inflated.

What Causes Differential Noises?

By R. A. Houston

MOST automobile drivers have observed that differential noises are periodic. For several months, perhaps, a well-oiled housing will develop a roaring noise that can not be located; then suddenly, for some unknown reason, the noise will cease. Later the roaring may develop again. This mysterious irregularity baffles most amateurs and many professionals.



It pays to look after the rear tires

In most cases the noise is caused by an inequality in the diameters of the two rear wheels. A heavily treaded cord tire can easily lose an inch of rubber from the tread and still be serviceable, but this loss reduces the diameter of the wheel two inches. Suppose that one of two 32-in. tires becomes so badly worn that it is replaced with a new shoe, while the other, also considerably worn, is continued in use; then one wheel might be 30 in. in diameter and the other wheel 32 in.

Unequal Tires Is One Cause

The wheel having the smaller diameter would also have the smaller circumference, and in traveling a mile the 30-in. wheel would make 672 revolutions while the larger wheel would make only 630 revolutions. The smaller wheel would make 42 revolutions a mile more than the wheel with the new shoe.

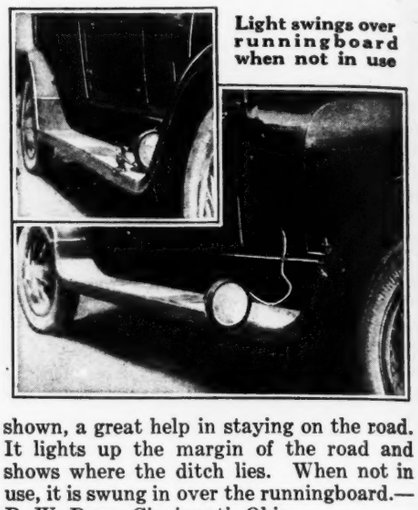
This condition calls into constant action the small pinion gears in the differential. There are three of these gears and they carry the full load of the car, but they are supposed to work only when turning corners. When these small gears, under enormous load, are called on to function continually, they soon wear, and since each of them makes several revolutions to one revolution of the wheel, the three worn gears combined produce the growling noise that comes from the differential housing. If the rear axle emits this sort of noise, look first to the tires. The trouble may be entirely with them.

Inflation also has considerable effect, because an under inflated tire may easily be 2 or 2½ in. smaller than its companion tire.

A little time spent in keeping tires correctly inflated may save a tire bill and a new differential assembly.

Runningboard Spotlight Aids Night Driving

AUTOMOBILE tourists and those who drive frequently on country roads at night will find a searchlight mounted on the right-hand runningboard of the car, as



Light swings over runningboard when not in use

shown, a great help in staying on the road. It lights up the margin of the road and shows where the ditch lies. When not in use, it is swung in over the runningboard.—B. W. REID, Cincinnati, Ohio.

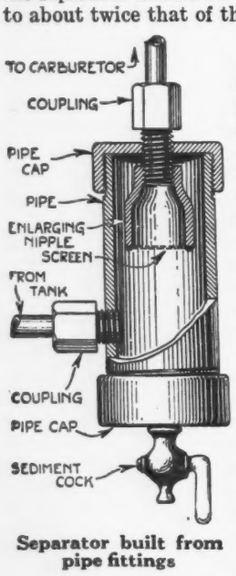
IN SEEKING the cause of rattling noises about your car, examine in turn the fenders, brakes, hood fasteners, lamps, doors, and springs.—F. B. J.

Homemade Separator Filters Sediment from Gasoline

By Howard Greene

A GASOLINE separator that will remove both sediment and water, can be made easily by following directions and illustration below.

No dimensions are given, because the size of the separator will depend entirely upon the size of the engine. The body of the separator should have a capacity equal to about twice that of the carburetor bowl.



Separator built from pipe fittings

The pipe caps at top and bottom are drilled for the nipple at the top and the sediment cock at the bottom. The big end of the enlarging nipple is fitted with a gauze screen; this is in two layers, soldered together and soldered to the end of the nipple.

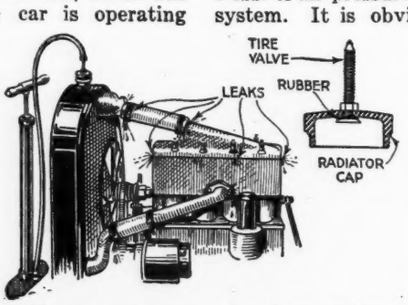
All the joints must be well made, for gasoline will leak through where water will not. It is much better to use brass pipe and fittings. If the gasoline used is more than ordinarily dirty, put an extra screen midway between the bottom of the enlarging nipple and the lead-in pipe. The separator can be drained by means of the sediment cock and the gasoline drawn off for priming and cleaning.

Once in a while the whole separator should be thoroughly cleaned by disconnecting the gasoline lead-in and unscrewing the body from the top cap.

Testing the Auto's Circulation System

By G. A. Luers

LEAKAGE at pump stuffing boxes and hose connections, which will open up when the car is operating on the road, often are not in evidence when the machine is stationary, and it is difficult to determine where the leaks are unless pressure is applied to the motor. If that can be done, the leaks will show up plainly.



How air pressure makes leaks visible

To apply the necessary pressure, it is necessary merely to modify a radiator cap by the addition of a tire valve, as shown. With this in place, pump about 5 lbs. of air pressure into the circulation system. It is obvious that a rubber gasket should be placed under the cap and a cork in the overflow pipe.

The same device is useful when flushing the radiator or using a scale remover, because the pressure aids materially in forcing the scale and muck out through the drain. When the location of a leak is known, it can usually be repaired easily.

Neat Striping Adds Final Touch to Repainted Car

EVEN the most careful job of repainting a car sometimes lacks a finished appearance because it has no striping. To add the stripes, the colors desired should be mixed to a rather stiff consistency. They should be thin enough to flow readily from the brush and yet be stiff enough to stay where put. A 10-cent water-color brush will do the work.

How the brush is held

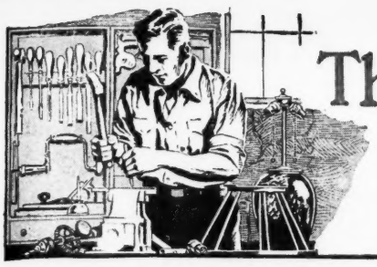
After the lines have been traced with white chalk or snapped on with a chalk line, the painter sets his cups of paint and turpentine on the side of an old varnish can and rests one end against the car to steady it. Then he dips the brush and carefully follows the chalked line, steadying his hand with his middle finger.

It is not as difficult as it looks and if a mistake is made, the line can be removed with turpentine and a rag and, when dry, gone over again.—DALE R. VAN HORN.

Hot Brick Starts Cold Motor

A SIMPLE expedient for starting a cold motor is to heat a common building brick in a stove or furnace and place it beside the carburetor. The heat radiated from the brick is sufficient to warm the manifold so that starting is possible.

The brick is carried in the engine pan and when a stove or furnace is not available, it is heated by pouring gasoline over it and lighting it. This provides a roadside method of getting a start regardless of the temperature.—F. J. E.

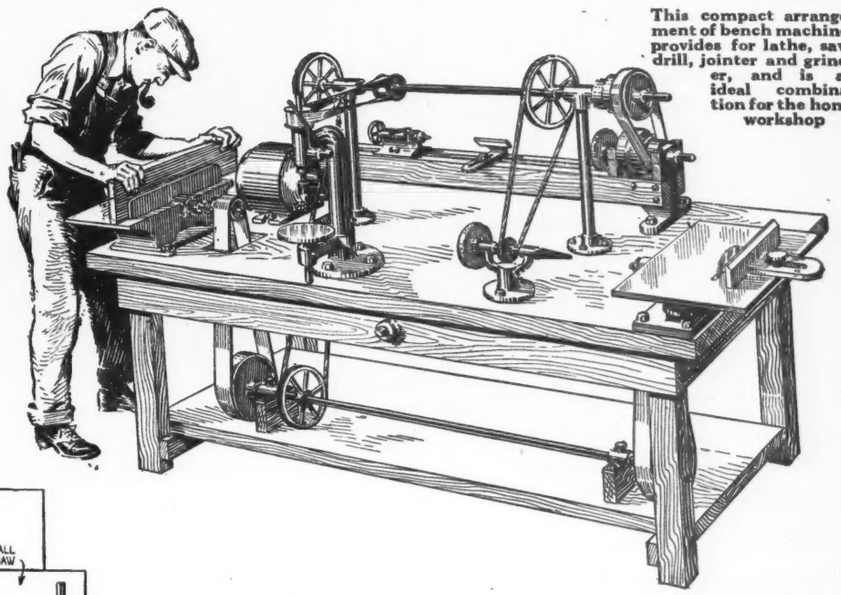


The Home Workshop

New and Useful Things to Make with Tools

How to Motorize Your Home Workshop

By Robert S. Lewis



This compact arrangement of bench machines provides for lathe, saw, drill, jointer and grinder, and is an ideal combination for the home workshop

JUST as machines have taken much of the drudgery from large shops, cheap electric power and sturdy and inexpensive small motors make it possible to eliminate tedious hand work from the home workshop. By motorizing his shop, the home worker can quickly repay the cost of installation through increased production and better and more accurate work.

The first point to be considered is the power needs of the largest and heaviest machine to be used. This will fix the size of the motor, since only one machine will be in operation at one time in the shop. Motors of ¼ hp. can be bought for $20 or less, sometimes considerably less, and they will drive almost any small machine. For the handy man and for a farm workshop,

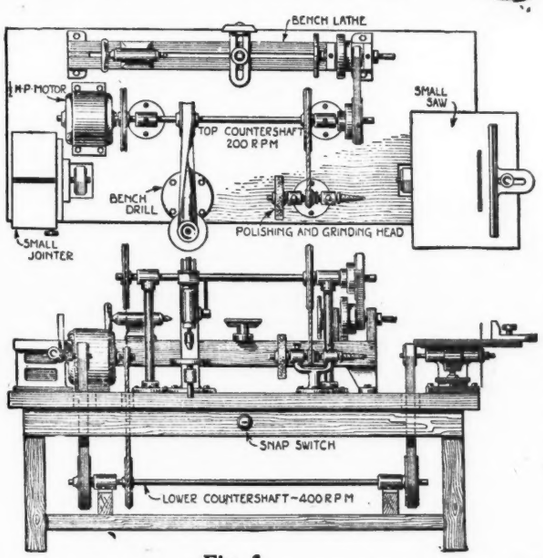


Fig. 1

where heavier work is done with floor type machinery, the motor must be at least from ½ to 1 hp.

Almost all types of hand or foot operated machinery can readily be converted into power machines by removing the cranks and levers and placing pulleys of suitable diameter on their shafts. Pulleys and shafting are relatively cheap, but if the builder wishes to cut down expenses to a minimum, he can make the pulleys of wood, iron, and other available materials.

For small bench machines, the usual plan is to centralize the motor and group the machines around the edges of the workbench. In this manner one or, at most, two shafts will suffice. Most of the ¼-hp. motors have a speed of 1750 r.p.m. This is reduced at the first countershaft to around 400 r.p.m., and is further reduced to about 200 on the second shaft. From these two speeds each type of machine can readily be belted up to the correct speed. Drill presses and woodworking machinery operate on the high speed shaft and small lathes and milling machines on the low speed shaft.

Small countershaft hangers and supports are readily made of standard pipe fittings, as shown. The base of the hangers are floor flanges into which are screwed lengths of pipe to serve as uprights. To these are fastened pipe tees, which are converted into bearings by pouring Babbitt metal into them after the shaft is properly alined and the lower opening plugged with paper, clay, asbestos or other substance to prevent the babbitt from filling the pipe. Cardboard disks are cut and slipped over the shaft and clamped in place to form dams for holding the babbitt in place.

The pouring is done through a ⅜-in. hole drilled in the top of the tee, and later an oil hole is drilled through the same place. To prevent the babbitt from sticking to the shaft, cover the shaft with thin tissue paper, the paper first being well soaped.

The installation illustrated in Fig. 1 is a good one for the woodworker's shop. The shafting arrangement is such that one short shaft reaches all the small tools, while the long shaft, beneath the bench, takes care of the bench saw and jointer. The drive from the motor to both shafts is vertical, the power being applied only to one shaft at a time. The different shaft speeds are obtained by using a pulley twice as large on one shaft as on the other.

When two shafts are placed on top of the bench, a number of different speeds are possible, and, if desired, the more important machines can be equipped with a tight and loose

(*Continued on page 117*)

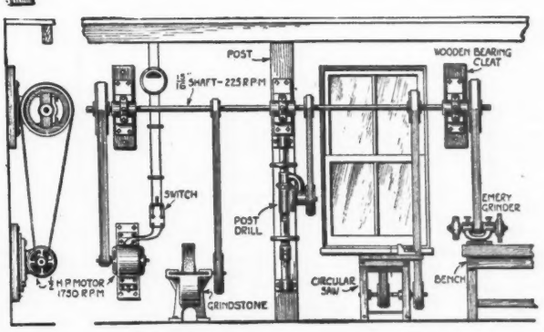


Fig. 2

Figure 1 at the upper left shows a woodworker's bench with motor and two countershafts for driving five small machines. Figure 2, above, is a general utility workshop with heavier machines, especially useful on the farm. Figure 3, at the right, is a space saving plan for the home machinist's bench

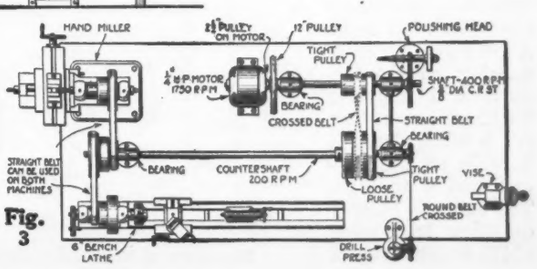


Fig. 3

The Secrets of Successful Stenciling

By P. A. Daschke

TO BE able to design and apply stencils is a most valuable accomplishment for the home worker, and one worth mastering. Stencils can be used for ornamenting many kinds of painted, enameled, and stained work, and will serve alike for decorating small pieces of furniture and large plaster or wallboard surfaces. There is nothing difficult about the process and the only precautions necessary are to choose appropriate designs and harmonious

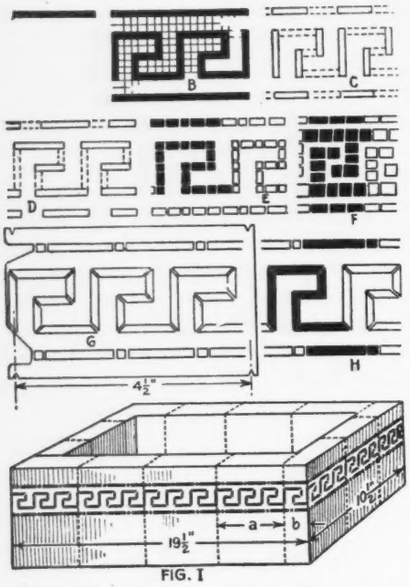


FIG. 1

Easily cut straight-line borders offer endless possibilities for the home decorator

colors and so avoid the cheap effect that indiscriminate or over elaborate use of stenciling is apt to create.

The simplest stencil element is a straight line *A*, Fig. 1. Simple Greek fret borders and other line designs, *B*, are easily drawn by ruling the paper into small squares or using cross-sectioned paper, which may be obtained at any stationery or art store. To stencil a continuous running design of this kind, it is necessary to cut two stencils in such a manner that the lines overlap by one square, so as not to leave any gaps, as at *C* and *D*.

The usual practice is to cut only one stencil and leave spaces or ties to be filled in later. The proper way is either to overlap stencils or to have the ties form part of the ornament, so that no filling in with a brush is necessary. The latter is the true art of stenciling, and the spaces are as much a part of the design as lead binding on art glass is part of its artistic effect. This is illustrated at *G*, where the fret is given the appearance of being mitered at the corners; at *E*, which resembles a mosaic setting, and at *F*, which shows a continuous running figure, the ties forming a background setting like mosaic or inlaid work. In this way may be prepared all sorts of artistic

(*Continued on page 122*)

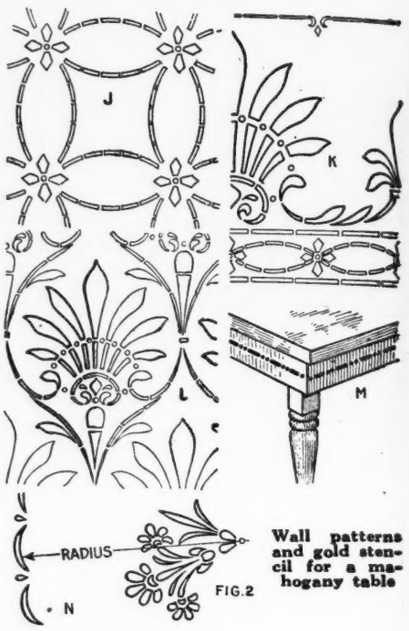


FIG. 2

Wall patterns and gold stencil for a mahogany table

Wind and Wheel Drive This Speedy Ice Bicycle

By George A. Luers

THRILLING and yet comparatively safe is the new winter sport of bicycling on the ice. The machine is equipped with skis and a jibsail, so that it is really a high speed scooter.

Three or four machines make possible 10- or 20-mile races around a one-mile circular track. There is just enough pedaling to keep the rider from being cold without the necessity for sufficient exertion to tire him. Although the scooter is intended for use on ice, the skis will support it on hard packed snow roads and will allow a speed of from 15 to 20 miles an hour; but more effort has to be put in the pedaling.

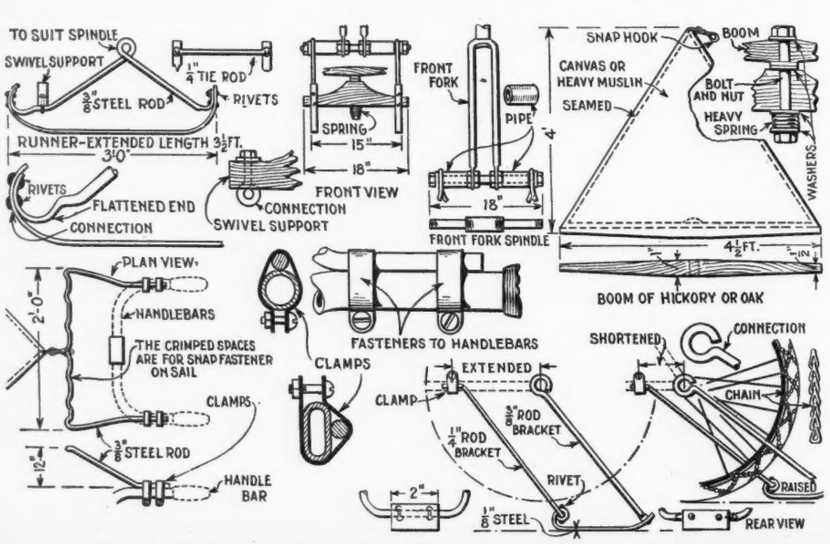
No cutting or disfiguring of the wheel is required in the construction of the scooter. In place of the front wheel, two parallel skis are attached by means of a center bar to the front forks and are controlled through the handlebars for steering. These skis or runners are ¾ by 3/16 in. steel strips, 3½ ft. long; the braces are ⅜-in. steel rods. A wooden cross member on the forward end supports the jib sail boom. The sail is triangular, 4½ ft. wide on the bottom and 4 ft. high. The boom is hickory or other hard wood 4½ ft. long and tapers from 1 in. in diameter at center to ½ in. at the ends.

The material for the sail is either canvas or closely woven muslin. A crimped wire span above the handlebars provides several places for attaching the top of the sail with a snap hook. The sail can readily be furled when the scooter is to be pedaled against the wind. The swivel joint of the boom at the skis is stiff, but will move at a tug on the sail.

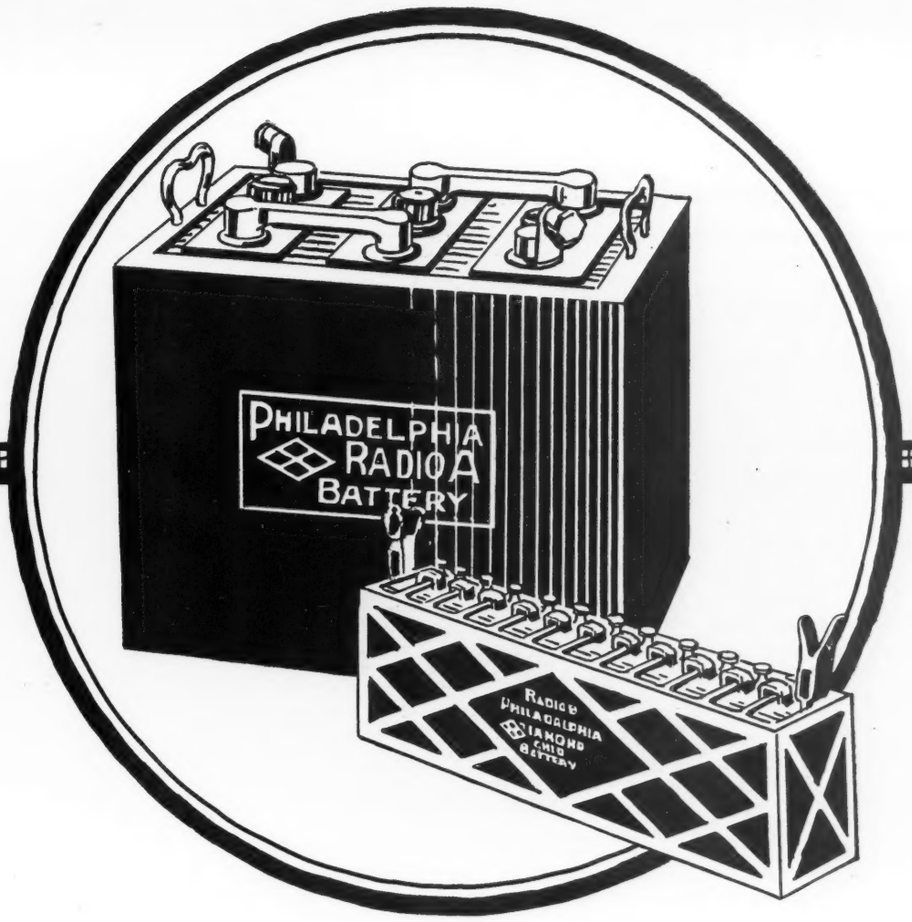
The rear ski or runner is a light bearing skid, which may be adjusted so as to be only a fraction of an inch above the wheel. This supplementary runner is for use on snow and prevents the wheel dropping below the surface; so that it also steadies the traveler's position when riding across ruts and tracks.

If desired, this runner may be adjusted so that the rear wheel is clear of the ice, as shown in the illustration, somewhat exaggerated for the sake of clearness. The scooter then depends entirely upon wind and sail for propulsion. The attachment is somewhat like a bicycle stand and is secured at the rear hub. The tie bars are ¼-in. steel rods with simple clamps to allow ad-

(*Continued on page 121*)



The parts of the scooter attachment and how they are added to the bicycle frame



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Better Shop Methods

How Expert Mechanics Save Time and Labor

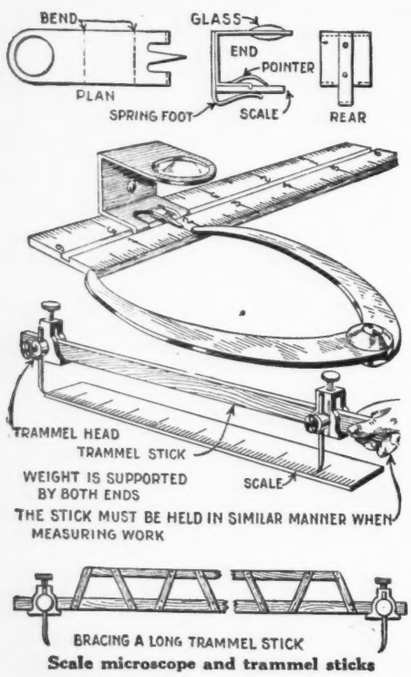
Making Accurate Measurements with Simple Tools

By Joe V. Romig

OF ALL factors that determine the success or failure of the mechanic, especially the machinist, that of accurate measurements is the most important. In large manufacturing plants, where interchangeable parts are produced, the demand for accuracy is met largely in the toolroom by expert design and workmanship in jigs, fixtures, and gages and ordinary methods of measuring are scrapped almost entirely. But, in the jobbing shop and the experimental department, where it does not pay to make gages for a single job or for a few pieces, accuracy in measuring finished surfaces depends upon the skill of the individual workman.

The difference between good and bad measurement is often simply a matter of common sense. Even very common tools will give surprisingly good results if properly handled.

A friend of mine is an inspector for a large machine tool company that sublets quite a bit of heavy work. He goes to the various plants working on the contracts and inspects the finished product before it is shipped. His tools for this important work



Scale microscope and trammel sticks

consist of a pair of 8-in. inside and a pair of 8-in. outside calipers, 12-in., 6-in., and 3-in. steel rules, and a reliable 50-ft. steel tape line. Of these, the tape line is used the most. His methods are simplicity itself and I have seen him check up the squareness of two right-angle faces with a tape line, using the time-honored 6-8-10 rule.

Ordinarily, if all of John's work can be expected to be a trifle large and if all of Jim's tends to be small, the reason is that each has his individual opinion of the proper amount of the line or graduation to include when setting his calipers or of the proper lightness or heaviness of their touch.

When plain calipers are used, often they are set either too tight or too large because the workman does not take pains to look squarely at the scale from a point precisely opposite the mark at which the tool is to be set.

To set calipers to a close degree of accuracy, a magnifying glass should be used. The simple attachment illustrated is designed to slide on a 6- or 12-in. steel rule. It is of thin brass, the glass being mounted over the pointer at the proper focal distance. The attachment is held in place by the lower spring so that it may be moved readily and yet will remain wherever set.

Leg and Micrometer Calipers

Even then, with a properly set caliper, the difference of the individual touch of the mechanic in applying the tool to the work will cause a variation in the measurements. To measure with an outside caliper, one foot should be held against the lower surface of the work, while the other foot is passed over the top, swinging or vibrating sideways, in order to locate the point directly opposite. When the foot will vibrate about 1/16 in. with a light scratchy feeling, the touch is correct. Likewise, on inside measuring with calipers, the feet should touch in the same manner.

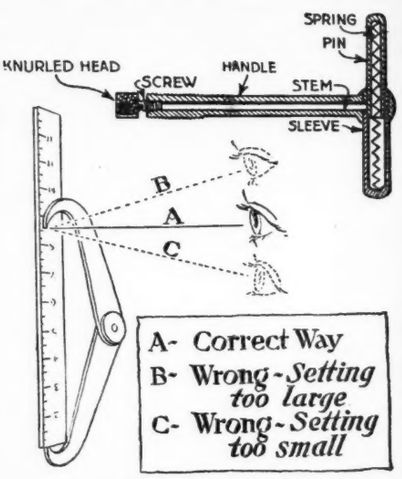
Micrometers, particularly those with ratchet stops, give far more uniform results in measuring, and the individual variation of touch is reduced to a minimum. This is due partly to the flat, parallel faces of the anvil and spindle ends, with their large contact on the surface of the work.

A handy tool for the machinist in measuring bores, which will give better results than a pair of inside leg calipers, is the inexpensive telescopic pin gage illustrated. When used in conjunction with an outside micrometer, it measures with the exactness of an inside micrometer. The smallest tool of this kind has a range of ½ to ¾ in. and the largest from 3½ to 6 in., with intermediate sizes between.

Many errors in measurement are made through the carelessness of the machinist in handling his trammel stick. Trammels should be held alike when setting and measuring; that is, the support should be in the same place, as any shifting of the position of support will surely spring the beam and give a false reading.

For measuring on heavy work, the handiest thing of all is the steel tape line. If not guaranteed accurate by the manufacturer, this should be checked against an accurate scale by laying the tape on a 4- or 5-ft. scale and comparing the graduations with a microscope. Stretched tightly across the bore of a large casting, or to the opposite sides of a flange, the tape will give accurate readings directly.

For the measuring of large outside diameters, the tape line is used on the circumference which, being a little more than three



Telescopic pin gage (above). Setting calipers (below)

times the diameter, will reduce any error to one third.

As the graduations of the tape line must be placed outwardly when measuring the circumference, it stands to reason that an allowance must be made for the thickness of the tape line itself. In other words, the circumference shown on the tape line is divided by 3.1416 and from that is subtracted twice the thickness of the tape.

It is worth while for the mechanic to increase his assortment of measuring tools whenever possible in order to have the assurance that he can handle any measuring job brought to him. Besides the usual outside and inside micrometers, there are many special calipers, scales, scale holders and gages.

STANDARD LOADS of DU PONT SHOTGUN POWDERS

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Turkey Geese	3½	1-⅛	2¾	1	2½	⅞	*2 & 4
Brant Large Ducks	3¼	1-⅛	2¾	1	2½	⅞	4 in flight 6 over decoys
Medium Ducks Grouse Prairie Chicken	3¼	1-⅛	2½	1	2¼	¾	6
Squirrels Rabbits	3	1	2½	1	2¼	¾	6
Small Ducks Pheasants Pigeons Doves	3¼	1-⅛	2½	1	2¼	¾	7½
Quail Snipe Woodcock Shore Birds	3	1 or 1-⅛	2½	1	2¼	¾	8
Reed Birds	3	1	2½	1	2¼	¾	10
Trapshooting	3	1 ¼	2½	1	2¼	¾	7½

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If BALLISTITE (*dense*) Powder is desired order by grains. A comparison follows of *Bulk* and *Dense* Loads:

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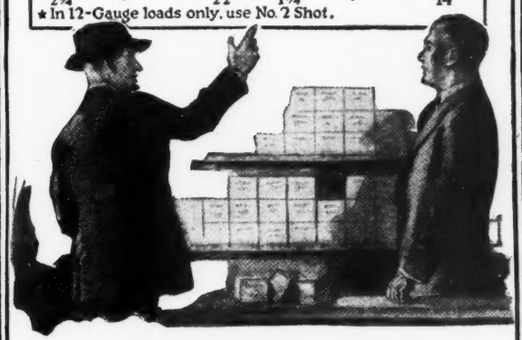
3¼	"	"	26	2¼	"	"	18
3	"	"	24	2	"	"	16
2¾	"	"	22	1¾	"	"	14

*In 12-Gauge loads only, use No. 2 Shot.



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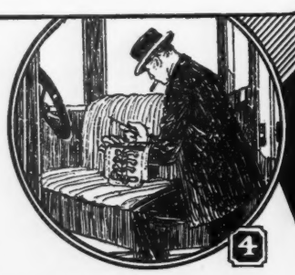

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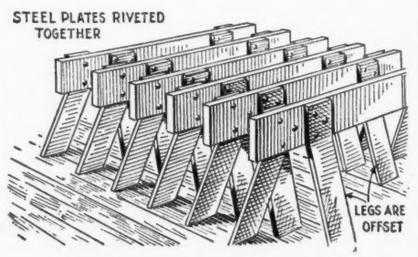
BETTER SHOP METHODS

Nested Steel Trestles Sustain Heavy Overloading

TWO advantages distinguish the type of trestle illustrated from those usually seen in shops where heavy loads have to be supported. The legs are so spaced that they are not opposite each other and the trestles therefore will nest together. This



The trestles can be crowded together for storage or holding heavy weights

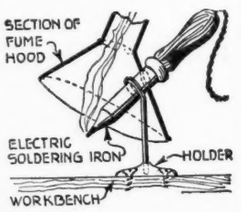
permits many trestles to be stored away in a corner of the shop or in a truck for transportation.

An even more important feature is that these trestles, which were devised for use in structural steel fabricating plants, will sustain enormous loading when they are placed close together.

The trestles are steel plate riveted in sections, although wood can be used.—E. S.

Holding the Soldering Iron

IN A certain plant manufacturing cream separators there is considerable soldering to be done, and to speed up the work the scheme illustrated was devised. Its simplicity is its chief advantage.

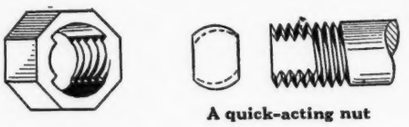


The gas heated iron formerly used was discarded and an electric iron substituted. Instead of the worker holding the iron, an iron stand was fastened to the bench at the proper angle. This allowed the operator to use both hands. A hood was placed over the iron to carry off the soldering fumes.

Much better work is possible by this method, which can be adapted for use in many cases where much soldering is to be done.—J. H. MOORE.

Locking Jigs and Fixtures

ON JIG and fixture work I often use the quick acting nut illustrated. It is a great time saver and does not take as long to make as many another locking device. To tighten or loosen this nut, it is neces-



A quick-acting nut

sary to give it only a quarter turn and it then can be lifted off. This saves the time of unscrewing.

Both the screw and the nut are cut away. The lead or pitch of screw thread should be coarse and both screw and nut should be hardened if the clamping device is to be put to much use.—H. P. BOETTCHER.

THE SIXTH SENSE OF INDUSTRY

Tycos Temperature Control

If a sense of "feeling" ruled the Rubber Industry!

SUPPOSE that raw rubber, taken from the initial softening vats was judged for pliability entirely by its "feeling" instead of the workmen's knowledge that the time of soaking and the water temperature was correct! Suppose that after passing through washing mills and rollers it was taken from the drying rooms when the men "judged" it was dry enough —instead of the time and temperature being exactly regulated! Suppose the result of the great kneading mills was guessed by feeling, instead of further exact heat control. Or that vulcanization—that all important process—had accurate heat control left out and the elasticity or hardness of the vulcanized product had to be judged by sense of touch alone!

Truly our rubber belting, automobile tires, rubber heels, moulded goods, combs, fountain pens, buttons, insulation, ballons, matting, storage batteries, and some thirty thousand other rubber products would be undependable and their life and usefulness an unknown quantity!

But sense of touch alone does not rule in the "bakeshop" that is really the modern rubber factory. Into the rubber industry enters that vitally necessary "sixth sense"—Temperature Control—supplied by the accuracy of *Tycos* Temperature Indicating and Recording Instruments. In great rubber factories everywhere *Tycos* Temperature Instruments are accepted as the standard of accuracy.

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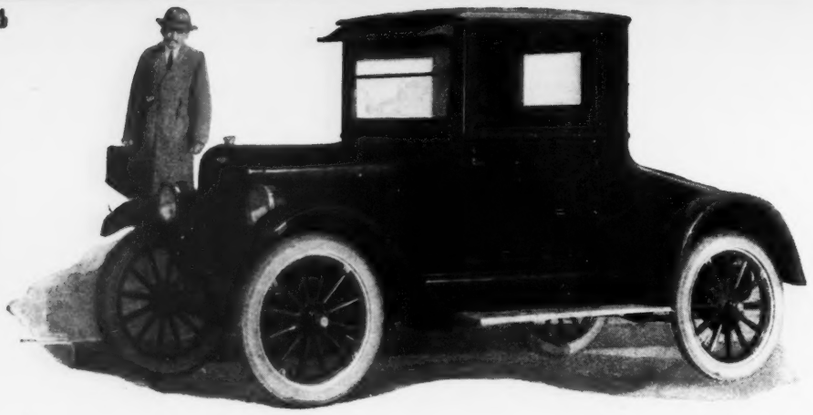

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Electrician's Wiring Manual

is as essential as his pliers.

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The 448 pages in the manual are filled with formulas, tables, practical hints—and 414 diagrams and illustrations.

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Popular Science Monthly

225 West 39th St., New York City

"How I Got that Better Job" Contest

FOR the three best contributions or letters on the subject, "How I Got that Better Job," POPULAR SCIENCE MONTHLY is offering a first prize of $30, a second prize of $20, and a third prize of $10.

Each contribution should be a first person narrative of shop experience that may help or stimulate mechanics to achieve better workmanship through improved methods or the application of novel ideas. Pencil drawings should be made to explain any obscure points, and if photographs are available to illustrate any phase of the article, they also should be included. Contributions may be any length up to 3000 words. They must be submitted on or before February 20, 1923.

An idea of the sort of article desired can be obtained by reading "How Do You Grind Your Tools?" by Joe V. Romig, on page 80 of the January POPULAR SCIENCE MONTHLY.

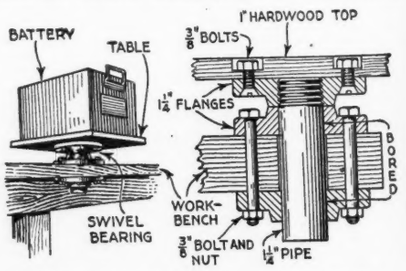
The contest will be judged by the Board of Editors of this magazine, and announcement of the prize-winners will be made in the May issue.

Address contributions to Editor, Better Shop Methods, POPULAR SCIENCE MONTHLY, 225 West 39th Street, New York.

Battery Repair Table Revolves on Repairman's Bench

A REVOLVING table is a useful addition to the battery repairman's bench. By being able to turn the battery in any position, the repair work is considerably simplified, especially such operations as soldering terminals and "pitching" shut the jars.

A hardwood board is cut a trifle larger than the outside dimensions of the batteries



The revolving table and details of swivel support

ordinarily handled, and is mounted on a 1¼-in. pipe flange. The ⅜-in. nuts of the stove bolts, which connect the two, are let into the surface. The base consists of two other flanges, the threads of which have been bored out to a sliding fit over the 1¼-in. pipe that forms the standard of the revolving table. One of these flanges is mounted above and the other beneath the top and the two are bolted in position with long ⅜-in. bolts.—E. L. F.

WORK that has been held in a magnetic chuck usually retains some of the magnetism. If no demagnetizer is at hand, and the character of the work will permit, a sharp blow on the floor will serve to remove the magnetism.

100,000 People in America

Have Been Benefited by Reading Coué's Book

All The Marvellous Cures Through Emile Coué's Method of Conscious Autosuggestion in Europe Were Accomplished by His Patients Following His Instructions. This Book Gives These Same Personally Uttered Instructions, Simply, Directly And Clearly, And Thousands of Americans Are Now Applying Them Daily With Amazing Results.

"Day by day, in every way, I am getting better and better"

Coué's famous formula is being repeated daily in twenty languages

THE world today is ringing with the name of a modest little Frenchman who has given glorious health, vital strength and abiding happiness to more people than perhaps any other living man—*and for all this remarkable service he has taken no fees.*

Many who were unconvinced and skeptical have tried Coué's methods at first as an experiment. Then, conscious of its good effects upon their physical and mental well-being, they have persisted in their efforts and gained complete freedom from many ills and disorders which had been troubling them for a long time. The letters printed here are from people who had been greatly helped by this book and who have insisted upon expressing their appreciation and joy. These are only a few from the scores that have come to us unsolicited.

Why Coué Wrote This Book

Crowds of people daily besiege Coué's home in Nancy, France, where he gives free treatment to all. But, realizing that he could expect to see personally only a comparative few of the millions all over the world, who can be helped by his methods, Coué has, at our request, with infinite care written out in detail his complete instructions, showing just how anyone can apply his methods for regaining or preserving health. The remarkable quality of these instructions, upon which everyone comments, is the fact that they are so plainly given that one reading gives a complete understanding of his method and opens the door to a new life for thousands of people.

THERE IS LITERALLY NO MAN OR WOMAN LIVING THAT THIS BOOK CANNOT HELP.

You can accomplish for yourself what thousands of others have by following the simple instructions in Coué's own book:

SELF MASTERY

Through Conscious

AUTOSUGGESTION

This Book not only contains a complete exposition of his theories and methods with thorough instructions, but also gives in detail some of his amazing cures which he has achieved for many people.

YOU Can Do What These People Have Done

"I have been troubled with stomach and bowel trouble for four years, sometimes incapacitating me from my daily avocation until I began to understand and practice the formula given by Emile Coué. I am well now and gaining weight and happiness all the time. For four years I ate only certain kinds of food. Now I eat any kind that I crave." **Mr. A. M. D., Ft. Smith, Ark.**

"Words cannot explain my happiness and joy. The doctors have been wanting to operate on me for nine years for a growth in the neck of my bladder. . . . after receiving Emile Coué's book and applying his method, all the inflammation is gone and the growth is also going away. I was having serious trouble with my eyes, which has also almost gone." **Mrs. A. B. C., Quincy, Ill.**

"For years I had a spinal curvature and I had given up hope of a cure, two or three bones being misplaced, making a hollow in the back. I hardly know how to explain it. I am very thankful to Dr. Coue to find that my spine is straightening and the hollow has filled out. Mrs. F. C. D., Poplar Hill, Md.

"I have had an almost complete healing from a chest pain that for years has given me the most terrible suffering—almost a death agony—whenever I would go up steps or walk hurriedly. I began to use the mental suggestion of the great scientist, Dr. Coué, as soon as your book came to me." **Mrs. C. H. W., Mansfield, O.**

"Emile Coué's method is the most effective of any I have tried. In its simplicity it works wonders. I cannot begin to express the torture of my body and mind which I suffered. Now, I am happy to say I am well and at peace." **Mrs. J. D. T., Charleston, W. Va.**

"Emile Coué's book has meant to me a source of Inspiration, a living fountain of Light and Life." **Mr. L. J. F., Pittsburgh, Pa.**

"It is the most remarkable and wonderful book I know of. It has not only cured my many physical ills, but better still, it has given me an understanding of myself. I am deeply indebted to Dr. Coue for the knowledge of the conditions necessary to Self Mastery, for I have apparently doubled my mental and physical efficiency." Mr. L. P. D., Lyme, Conn

"The benefits I have derived from this book have simply been marvellous. Before reading Dr. Coué's book I was constantly brooding and very melancholy. Now everything again seems bright and I am enjoying life as I haven't before in thirty years." **Mr. H. G. S., Oconomowoc, Wisc.**

"That little book is a revelation even to one who has spent the best part of his 77 years in psychology and it opens a new era of great possibilities." Mr. G. J. O., Los Angeles, Cal.

"Emile Coué's book is a godsend to suffering humanity, especially for nervous people. I have cured myself of worry and hurry and nerves of all kinds, until today, thanks to God and M. Coué I am a well and happy woman." **Mrs. C. A. B., Marshall, Texas.**

The remarkable effectiveness of Coué's method lies in its complete simplicity. It does not advocate any complicated system of diet, medicines, exercise, straining of the mind or forcing of the will. It reduces to simple formulas the great and powerful laws of mental action in such a way that everybody can understand and use his method with immediate results in curing bodily ills, correcting nervous disorders, strengthening character, eliminating fear and in building up in general an abundant reserve of physical and mental health.

Autosuggestion is an instrument that all of us possess at birth. Its use as taught by Coué is based on the power of the sub-conscious mind. The sub-conscious is a force which has too long been neglected in its possibilities for physical and mental health. Physicians and others have long recognized its importance but it has remained for Coué, the modest French scientist, to simplify its principles and laws making them practical and vitally effective so that anyone can use them. Coué shows definitely how you can command the forces of the sub-conscious to work for you according to your individual requirements.

The secret of Coué's method

is just that it helps to lull the conscious mind into a drowsy state and allows the suggestion of improving health and power to sink its roots deeply into the unconscious, getting it to accept ideas of health and success. All the forces of your being will then be directed to achieving these ideas without ordeal or effort by merely with the pleasurable sensation of good work being well done.

Science has only lately discovered some of the truths about the unconscious mind. Coué stands out today as the man who has invented an ingenious method of putting its secrets at the disposal of us all. He has presented men with a new key to the inner storehouse of vast powers of vitality. The practicability of this method is being attested to by an ever increasing host of believers.

Lord Curzon, Foreign Minister of Great Britain, and **Lady Beatty,** foremost English hostess, were the first world prominent people to be cured by Coué. Lord Curzon suffered from a particularly serious case of insomnia of long standing, which the best physicians of England could not cure or relieve. Both of these important personages made public acknowledgements of their cures, giving Coué full credit. There are hundreds of other prominent people who have been cured by Coué but who have no wish to make the matter public.

Luther Burbank, the famous botanist, has written the following tribute, which is impressive: "Emile Coué merits our joyous admiration, universal love and immortal thanks for his wonderful emancipation proclamation contained in his book."

Dr. Frank Crane, whose famous editorials reach millions of people daily and who is one of the most important forces of public opinion, said recently: "Emile Coué helps people to get well by Autosuggestion."

Henry Ford, the hard-headed apostle of common sense, said in a recent interview: "I have read Coué's philosophy; he has the right idea."

Chauncey M. Depew says: "There is truth in the Coué gospel."

Just $1.00 (no other payment) will bring you this book giving complete information how to use Coué's methods. Whether you are sick or not you can benefit by this information as it will contribute in many ways to making your life richer and happier.

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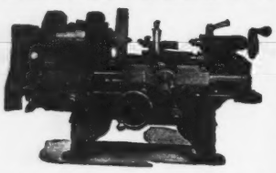
9-inch swing, 2½ ft. bed.



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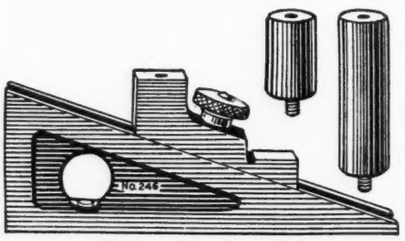
BETTER SHOP METHODS

What Tools Can You Lawfully Make?

EVERY practical tool user and all of our readers who are interested in inventions or in patents on new tools, or improvements on old tools, will find illuminating a recent experience of POPULAR SCIENCE MONTHLY.

On page 92 of our December, 1922, issue, a contributor described a planer gage with several useful features, constituting an improvement on gages of this type commonly in use. So novel a device did we believe this to be that, in the interests of our readers and at considerable expense, we prepared blueprints to facilitate the construction of the tool.

It developed later that the L. S. Starrett Company, of Athol, Mass., has a broad



A useful planer and shaper gage made by the L. S. Starrett Co. under patent No. 1,202,114

patent that not only covers the well known planer gage it manufactures, illustrated on this page, but also protects that company on any other gage of the type represented by that tool. Under the patent laws, therefore, no individual may make, even for his own use, the improved planer gage described in the article mentioned, without license from the L. S. Starrett Company.

When a patent is granted by the United States Patent Office, the drawings that form a part of it are published and may be reproduced and described by any magazine. It is not lawful, however, to make the patented article without permission from the owner of the patent.

For this reason POPULAR SCIENCE MONTHLY publishes in the Home Workshop and Better Shop Methods departments instructions for making only such devices as are not patented.

It is needless to say that POPULAR SCIENCE MONTHLY would not have published the improved planer gage design, excellent as it is, if it had known of the patent rights of the L. S. Starrett Company, and we have therefore withdrawn the offer to supply blueprints. Neither did the toolmaker who designed and made the improved gage happen to know of the existence of the Starrett patent (later called to our attention as No. 1,202,114; granted October 24, 1916, with broad claims covering such tools).

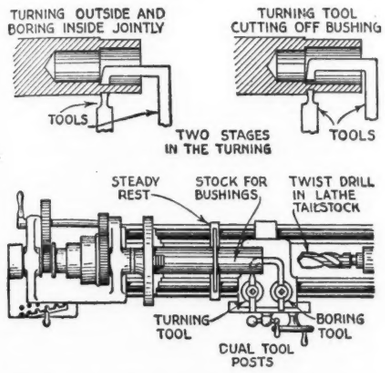
The difficulties of improving various tools and processes without infringeing on the rights of owners of previous patents are obvious, but the inventor of an improvement on a patented device will generally find that reputable, establi hed manufacturers of tools encourage new ideas and give fair treatment to those who submit such inventions to them.

It was to stimulate the development of labor saving and time saving ideas that the Better Shop Methods Department was founded and its aim is to pass along these ideas for the benefit of the other fellow.

BETTER SHOP METHODS

Dual Toolposts Will Speed Up Production of Bushings

TO INCREASE production in bushing work or in turning parts of the general shape of a bushing, the lathe tool mounting illustrated is an expedient of value. The work is accomplished with a single tool set-up and only the stock and steady rest are moved to repeat the operation after one bushing is finished. In application this



With this double tool set-up the bushings are turned and bored at the same time

method resulted in cutting the time of production to one fifth the usual time and effected a corresponding saving in labor expended on the job.

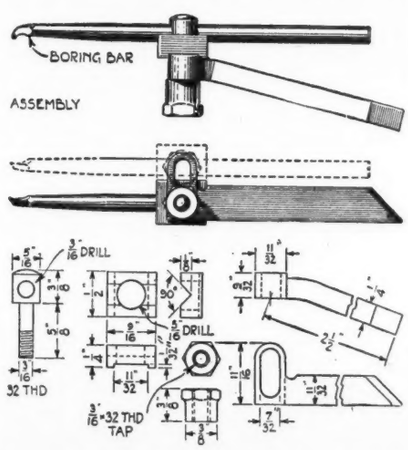
Two toolposts are mounted in the tool-post slot. One tool turns and the other bores the stock after a twist drill in the tailstock roughs out the center of the bushing.

The cross feed screw is then operated so that the outside turning tool cuts off the completed bushing.

A steady rest prevents the stock from springing.—G. A. LUERS.

Holder Raises and Lowers Bench Lathe Boring Tool

THE feature of this bench lathe boring-tool holder lies in the ease with which the tool may be raised or lowered to the center of the work. The parts of the holder



A useful tool for fine work on a bench lathe

and the method of assembling them are made clear in the illustration.

The tool is quickly made up and will repay the labor required many times over for any machinist who does fine work on a bench lathe.—S. L. ROBERTS.

"Drilling days are never over"

Makers of Mr. Punch

HAND DRILL
No. 1515 Price $4.80

This is a single speed drill. It has a screw cap containing 8 tool steel drills, 1/16 to 1/64 inch.

"Soldiers have a lot of drilling to do," observed Mr. Punch, "but so have carpenters and mechanics and any man who uses tools. For them every day is Drilling Day.

"I've found, however, that drilling a lot of holes has no terrors for the man who uses this Goodell-Pratt Hand Drill. It does its job so thoroughly that you'll consider it one of the best tool investments you ever made."

This Hand Drill has all the qualities that have made Goodell-Pratt Tools famous. Its frame is aluminum, giving as great strength as iron but much lighter weight. The superior design and construction throughout will appeal to the most particular mechanic and general user of good tools.

From selection of raw material to final inspection before shipment no effort is spared in producing a hand drill of the highest grade, a drill that will give long and useful service.

Your hardware dealer has this hand drill or can get it for you. Meanwhile, write for our free illustrated catalog No. 14 showing all the Goodell-Pratt 1500 Good Tools. There are many that will interest every man who uses good tools.

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1500 GOOD TOOLS

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TO FINE MEASUREMENTS
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Brown & Sharpe Machinists' Tools
—And the younger mechanics soon learn the value of having a kit of these fine tools when their work gets into close limits.
Use Catalog No. 28 in your selection of the finest tools you can buy.
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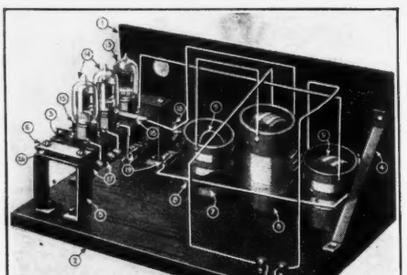

The vacuum tube set with two stages of amplification, from rear of panel

For men who like to make things at home with tools POPULAR SCIENCE MONTHLY is now publishing, in addition to its popular woodworking plans, an invaluable radio blueprint. This blueprint is easy to understand; the receiving set described requires the purchase of the fewest possible number of parts.

Should Receive 500 Miles

Under favorable conditions, if a long, high aerial is used, this receiving outfit will receive 500 miles. The blueprint contains working drawings, instructions, and bill of materials of a two-stage regenerative receiving set that a professional would be proud to own. It comprises a variocoupler and an Armstrong two-variometer-regenerative tuning circuit coupled, if desired, with two stages of audio frequency amplification.

The tuning coils have been selected because of the ease with which they may be constructed at home.

In this set has been incorporated the best features of several types of outfits. It will tune from 180 meters to about 600 meters with remarkable sharpness and selectivity.

Popular Science Monthly,
225 West 39th St., N. Y. City

Enclosed is 25c for which please send me the blueprint of the two-stage regenerative receiving set.

Name.....

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P. S. Feb. '22

BETTER SHOP METHODS

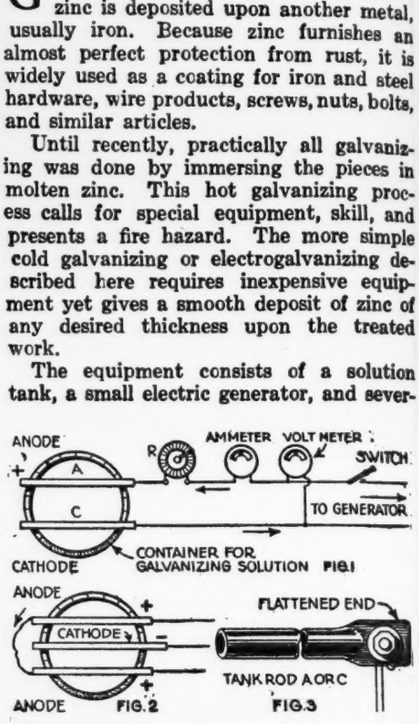
An Electrogalvanizing Process for the Small Shop

By K. M. Coggeshall

GALVANIZING is a process by which zinc is deposited upon another metal, usually iron. Because zinc furnishes an almost perfect protection from rust, it is widely used as a coating for iron and steel hardware, wire products, screws, nuts, bolts, and similar articles.

Until recently, practically all galvanizing was done by immersing the pieces in molten zinc. This hot galvanizing process calls for special equipment, skill, and presents a fire hazard. The more simple cold galvanizing or electrogalvanizing described here requires inexpensive equipment yet gives a smooth deposit of zinc of any desired thickness upon the treated work.

The equipment consists of a solution tank, a small electric generator, and several measuring instruments. While a manufactured wood or steel tank is much to be preferred, quite satisfactory results may be obtained with a half section of an old vinegar barrel. The inside surface of this container should be well covered with asphaltum paint to insure against acid leakage. Several such half barrels may be connected electrically in parallel, if necessary, to obtain the required capacity.



Wiring diagram and detail of end of cathode and anode rods

The Electrical Circuit

The source of electric-current supply may be either a battery or a generator. The former can be used only where the articles to be plated are small in size and quantity. Moreover, a battery has many limitations and requires much attention. A generator should therefore be secured having a current pressure of from 3 to 6 volts, but with a comparatively large current capacity. A current of approximately 2 amperes a square foot of plated surface is necessary. The generator may be driven by either a small gas engine or an electric motor, but its speed of rotation must equal that designated upon the name plate if the highest efficiency is expected.

The electrical connections should be made as noted in Fig. 1. Two brass or copper tubes, *A* and *C*, serve as the anode and cathode supports. If possible, two anode supports, as shown in Fig. 2, should be furnished, since such an arrangement of anodes allows a uniform deposit upon both sides of the plated work. One end of each tube should be flattened and drilled, as in Fig. 3, so a bolted connection may be easily made.

A rheostat is connected in the circuit to

(*Continued on page 89*)

BETTER SHOP METHODS

An Electrogalvanizing Process

(*Continued from page 88*)

regulate the plating current upon which the rate of deposit depends. If possible, an ammeter and a voltmeter should be used to indicate the working conditions.

Care must be exercised to see that the current flow is in the direction noted—toward the anode and from the cathode.

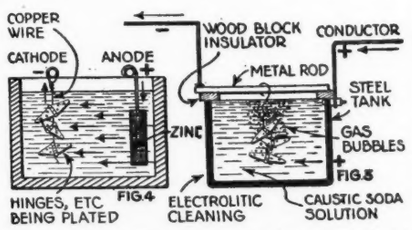
The anodes must necessarily be of zinc, commercially pure. While sheet zinc may be used, much better results are obtained if cast metal is employed. Commercial cast zinc anodes may be purchased in many forms—round or elliptical bars and flat or corrugated plates. It is usually best to provide an anode surface at least 35 per cent greater than the total area of the parts to be plated.

There are two general types of galvanizing solutions, acid and alkaline. The former is "fast," but unless care is taken, it tends to show a granular deposit. The latter forms the coating somewhat slowly, but usually produces a finer finish.

A simple formula for an acid solution is:

Water	1 gal.
Zinc sulphate	2 lbs.
Aluminum sulphate	4 oz.
Ammonium chlorid	2 oz.

Dissolve the zinc sulphate and the ammonium chlorid in a little water. The aluminum sulphate is then dissolved in another portion of water and added to the first solution. Strange as it may seem, the addition of 1 oz. of grape sugar or glucose will improve the smoothness of the deposit.



Diagrams showing method of the galvanizing process and electrolytic cleaning

Bath Must Have Acid Reaction

Precautions must be taken to make sure the bath is not neutral; it should have a slight acid reaction. Blue litmus paper, if dipped in the electrolyte, will turn red immediately if the solution is acid. Should this test show the bath to be neutral, add a very small quantity of sulphuric acid until the litmus paper no longer remains blue. A spongy, rough deposit is a good indication that the bath is in a neutral condition.

A much-used cyanide galvanizing solution, which should be heated when used, is:

Water	1 gal.
Zinc cyanide	4 oz.
Sodium cyanide	4 oz.
Aluminum sulphate	¼ oz.
Caustic soda	4 oz.

The zinc cyanide and sodium cyanide are dissolved in one portion of water, the caustic soda in another, and the aluminum sulphate in another. The three solutions are then mixed together.

The pieces to be plated must be chemically cleaned. The slightest trace of grease or oil, or even a finger mark, will cause the deposit to be defective. The pieces should be strung on short lengths of wire, or if this is not possible, placed in a wire basket. If

(*Continued on page 90*)

Standard Keyboard

Examine this keyboard carefully. Key for key, you will find it an exact duplicate of the keyboard on the big typewriters. Nothing new to learn, and nothing to unlearn when you start to write on the

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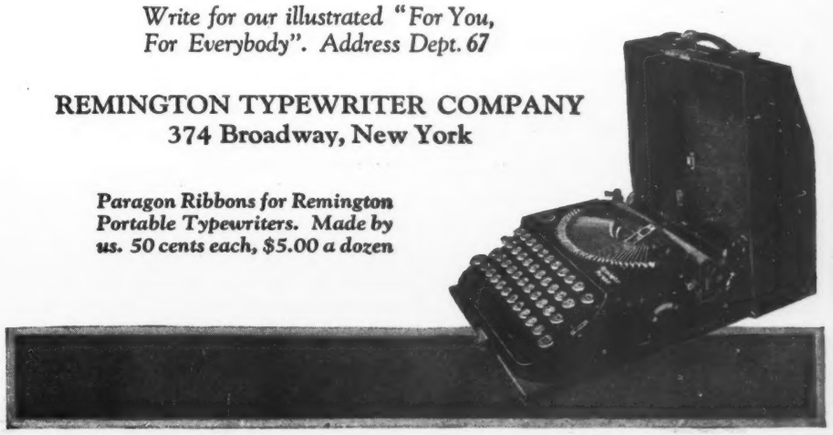

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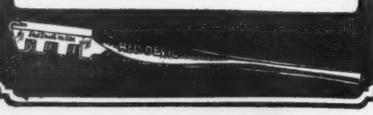

BETTER SHOP METHODS

An Electrogalvanizing Process

(*Continued from page 89*)

the articles are quite rusty or covered with scale, it may be necessary to suspend them in a pickle bath for a short time. The pickle is usually composed of a solution of several diluted acids. Iron articles may be best treated in a bath of 20 parts water to one of sulphuric acid. If it is convenient to heat this pickle, the process will be shortened. Rinse well in cold, and in hot water after removal from the pickle.

Other Cleansing Precautions

One of the quickest and easiest methods of cleaning metal articles, however, is by an electrolytic process. A small steel or iron tank is used, the positive side of the generator being connected with it. The negative terminal is connected with the piece to be cleaned, which is suspended in a caustic soda solution contained in the iron tank. This solution should be maintained at a temperature near the boiling-point by some heating unit—steam coils, for example. The foreign substances on the treated articles are quickly thrown off by the action of the hydrogen gas formed on the surface. Note Fig. 5.

If these treatments fail to remove all stains, it may be necessary to polish the pieces, using a wheel set up with fine emery.

The foregoing cleaning processes may be omitted should the parts to be plated appear reasonably free from foreign matter. However, they must be immersed for approximately twenty minutes in a hot lye solution composed of from 30 to 40 parts of water to 1 part of lye, by weight. Rinse the pieces in cold water immediately after they are taken from the solution.

Scouring with fine pumice-stone is sometimes done where the surface still appears to require treatment beyond that of the lye dip.

Just before hanging the pieces in the tank, they are quickly dipped in an undiluted solution of muriatic acid to remove any existing oxid, and finally rinsed in clean. cold water.

The Plating Process

The pieces, still strung on the copper wire, are then suspended in the electrolytic bath, the free end of the wire being connected with the cathode support, *C*, thus completing the electric circuit. Note Fig. 4.

The plating current is carefully regulated by means of a rheostat, to obtain the desired fineness of deposit. Too heavy a current will "burn" or blacken the coating.

After removal from the bath, the piece should be rinsed thoroughly in hot water, then dryed in warm sawdust.

A protective coating thus obtained will wear almost indefinitely.

Milling Thin Work

WHEN milling thin work, a coarse feed will distort the work less than a fine feed. Slight irregularities in the cutter cause some teeth to cut more heavily than the others, and as a high tooth comes in contact with the work, it strikes a blow that produces a slight peening action. With a fine feed, this peening action takes place a greater number of times in the length of the work and consequently causes greater distortion.—R. H. K.

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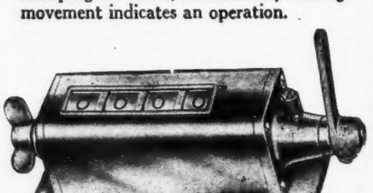
Veeder COUNTER

The small Revolution Counter below registers one for a revolution of a shaft, recording a machine operation, or product. Though small, this counter is very durable; its mechanism will stand a very high rate of speed, making it especially suitable for light, fast-running machines, and most adaptable to experimental work. If run backward the counter subtracts. Price $2.00. (*Cut 4/5 size.*) Small Rotary Ratchet Counter, to register reciprocating movements of small machines, also $2.00.

The Set-Back Rotary Ratchet Counter below is for the larger machines, such as presses and metal-stamping machines, where a *reciprocating* movement indicates an operation.



Registers one for each throw of the lever, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, $11.50—subject to discount. (*Cut less than ½ size.*) Set-Back Revolution Counter, to count revolutions of a shaft (large model like the above), $10.00 (list).

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44 Sargeant St., Hartford, Conn.

BETTER SHOP METHODS

Tricks in Testing Bench Lathes

FOR some years I have been interested in small bench lathes. Until recently the method of testing was as follows: The test bar was inserted in the bearings and locked by screws in the bearing caps and a block with a V edge to correspond to the shears of the bed (front side) was used with a dial indicating gage. Measurements were made from the lathe bed to the test bar at the headstock close to the bearing, and again at the end of the test bar, 28 in. from the bearing. I had allowed an error of .002 in. in 24 in., the test bar projecting from the front bearing by about 28 in.

A question was raised as to the amount of deflection of the test bar, and I ventured

Testing alinement of headstock bearings

the opinion offhand that it would not amount to more than .0015 in. on the 28 in. length; but on referring to a textbook and using the given formula, the deflection proved to be .008. This upset all our calculating. When the bar showed zero at the headstock end and .002 in. high on top at the tailstock end at 28 in. overhang of the bar, it really was .010 in. high at the end instead of being only .002 in. as shown at the indicator, the deflection accounting for the .008 in.

Next, by taking a test at 12 in. overhang, the deflection was less than .001 in. Now to prove if the deflection was actually .008 in., the test bar was again inserted at 28 in. overhang and the bearings tightened up so that the bar was rigid. The gage showed at zero at the extreme end of the bar on the side test, with the lathe in its ordinary position. The lathe was then turned on its side 90 degrees and the gage again tried up against the bar, when it showed that the deflection was slightly more than .008 in. It actually registered .0105 in., showing that another factor had to be taken into account, and that was the pressure of the spring in the dial gage. A test was made on this and it showed that the pressure of the spring registered a deflection of .0025 in. on the test bar at 28 in. overhang. The diameter of the bar was 1¼ in. and it was made from ordinary good mild steel approximately 35 to 40 tons tensile.

We had the records filed away for future reference and decided that in future all our tests would be made on a bar projecting 12 in. from the headstock, as the deflection on this length was under .001 in. All this goes to show how easily one can be led astray until actual experiments are carried out and very carefully checked.—F. H. SWEET.

Dr. Frank Crane
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in Current Opinion

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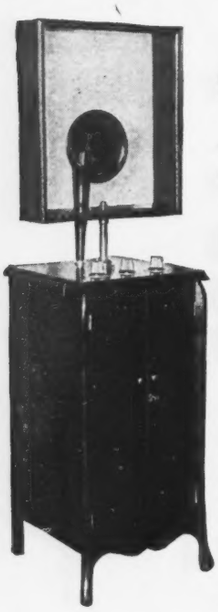

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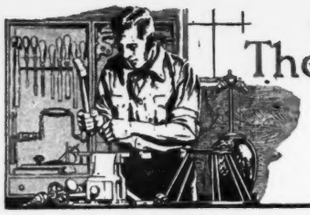


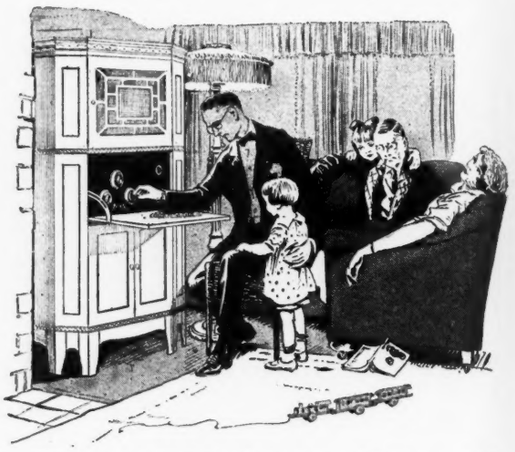
The Home Workshop

(Continued from page 78)

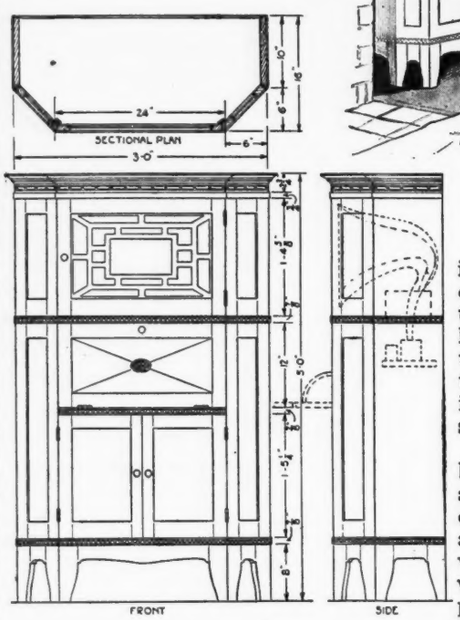
Building Your Own Radio Cabinet

AFTER mastering his home-made receiving set, the radio fan invariably wishes for a suitable cabinet. He wants something that will be as permanent and beautiful a piece of furniture as a cabinet phonograph.

There are many styles of cabinets that can be built at home, ranging from the simple boxlike case described in the Home Workshop last May, to the elaborate inlaid cabinet that is illustrated above. For a crystal set a box serves very well; for a vacuum tube set it is better to make provision for the storage battery, unless it can be kept conveniently in the cellar and wires run from it up to the set. The cabinet also should provide a place for the loudspeaker, which invariably is added sooner or later to every set that has the necessary stages of amplification.



A walnut radio cabinet with inlays. Additional working details and a complete bill of materials are contained in Home Workshop Blueprint No. 16

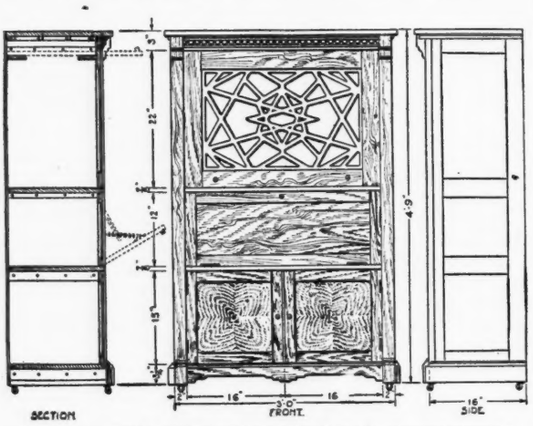


The cabinet shown above can be built by any home worker who has taken high school manual training or who has built pieces of furniture such as the home workshop kitchen cabinet, hundreds of blueprints of which have been used. The instrument panel and set itself are placed in the middle compartment. The upper compartment with a fretwork door is for the loudspeaker, and if the horn is a very large one, the base of it is let down into the center compartment, as shown by the dotted lines. The lower compartment is for the A and B batteries, tools, and spare parts.

By taking care every step of the way, the builder can make, at relatively small cost, a cabinet that will not only be unique and different from anything that can be bought at furniture shops, but that will have a value as a handmade piece far in excess of what the average radio fan could afford to pay for a manufactured cabinet, as a glance at price lists would show him.

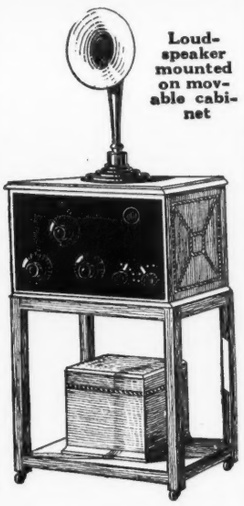
The frame is walnut and the panels are 5-ply burl walnut veneer. If burl panels cannot be obtained readily, try to pick out good stump veneer or fiddleback figures. It is not difficult to get veneers that are exceedingly beautiful in grain, that will stand out in contrast to the plain walnut of the frame. For cheaper construction use red gum for the frame either with walnut or red gum veneered panels. The top or cornice section, which has a stock molding, and the base section and legs are made separately from the cabinet proper and are fastened to it with dowels.

The inlays, which add so largely to the attractiveness of the cabinet, are not particularly difficult to handle, since they are purchased ready made. A gage with the spur sharpened to a knife point, a



Another simply made radio cabinet with compartments for the receiving set, loudspeaker, battery, and tools

knife, chisels, and, if available, a scratch stock, are used for cutting the necessary recesses. These should be not quite as deep as the inlays are thick, so that, after the glue is dry, the inlays can be dressed flush.



Loudspeaker mounted on movable cabinet

The panel of the top door is fretsawed and backed with brown silk. If the modern craft finish is desired, stain the wood, brush it with one part shellac and one part denatured alcohol, paint it with thin silver gray flat oil paint, wipe the wet paint off across the grain and

(*Continued on page 94*)

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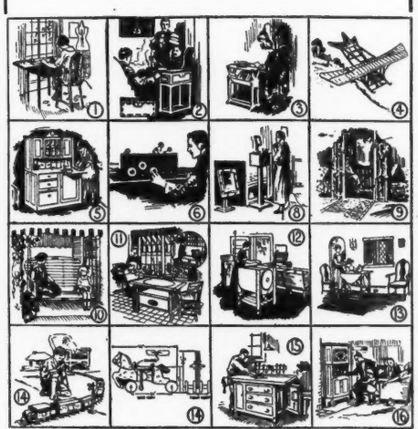

Above are illustrated the blueprints issued to date by the Home Workshop

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3.	Book Trough End Table	25c	☐
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8.	Shaving Cabinet	25c	☐
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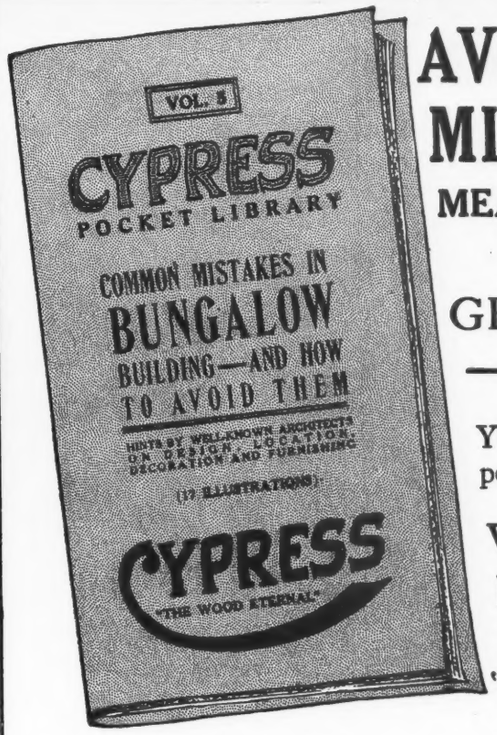

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Makers of "Silver Steel" Saws and Tools

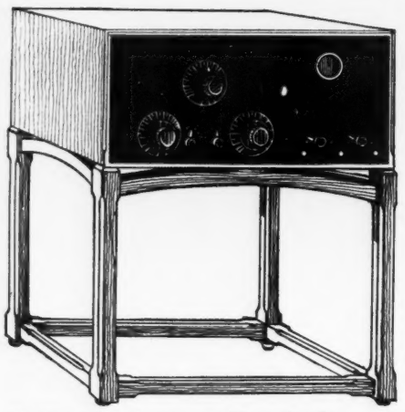
Building a Radio Cabinet

(*Continued from page 93*)

finish with several coats of good varnish.

If a loop aerial is used with this cabinet, it should have folding feet so that it can be slipped behind the cabinet.

The lower design on page 92 is a cabinet somewhat similar but without the cutoff



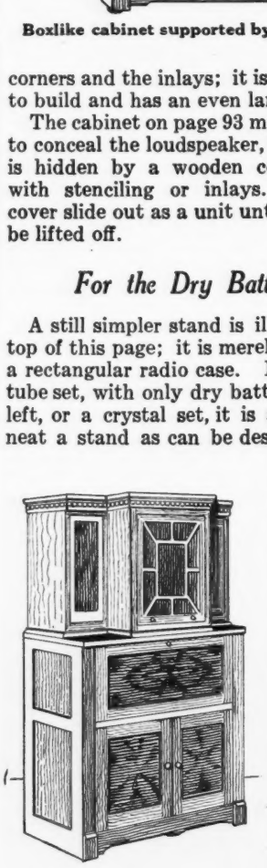
Boxlike cabinet supported by a simple stand

corners and the inlays; it is therefore easier to build and has an even larger capacity.

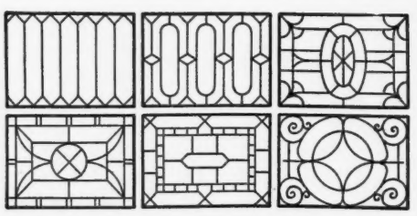
The cabinet on page 93 makes no attempt to conceal the loudspeaker, but the battery is hidden by a wooden cover, decorated with stenciling or inlays. Battery and cover slide out as a unit until the cover can be lifted off.

For the Dry Battery Set

A still simpler stand is illustrated at the top of this page; it is merely a support for a rectangular radio case. For a "peanut" tube set, with only dry batteries, shown at left, or a crystal set, it is as compact and neat a stand as can be desired. The cabinet has two small bookcases at each side of the compartment for the loudspeaker.



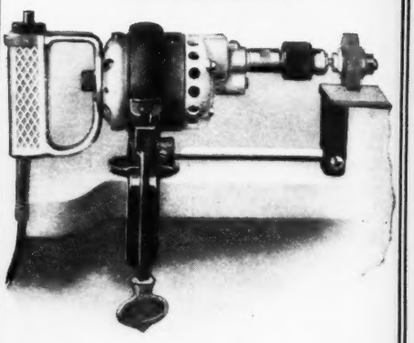
When time is limited, a good way of getting a cabinet is to buy a music or music roll cabinet or a phonograph record cabinet and adapt it for holding



A large cabinet with bookcases on each side of the horn chamber, and suggestions for fretwork doors

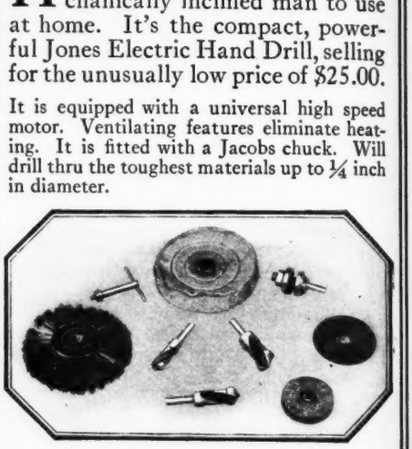
the set. It can then be improved at leisure, if desired, with either carving or inlays.

A Complete Machine Shop In One Tool



HERE'S just the tool for the mechanically inclined man to use at home. It's the compact, powerful Jones Electric Hand Drill, selling for the unusually low price of $25.00.

It is equipped with a universal high speed motor. Ventilating features eliminate heating. It is fitted with a Jacobs chuck. Will drill thru the toughest materials up to ¼ inch in diameter.



For slight additional cost useful attachments are available for grinding, polishing, buffing, sawing; also a grooved step pulley which can be used for driving light machinery. A complete machine shop or power plant in one tool.

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Prizes of $15 and $10 Offered for "Best Ideas"

TO ENCOURAGE readers of the Home Workshop to send in the good ideas they come across in their work with tools, two prizes of $15 and $10 are offered every month. These are awarded for the "Best Ideas" published for the month in the Home Workshop Department, and are a bonus given in addition to the regular rates of payment.

Any article suitable for this department is considered eligible for a prize, provided it is submitted by a reader or contributor not connected with the magazine staff. Each idea should be illustrated with a photograph, sketches, or both.

The February prizes are awarded as follows:

FIRST PRIZE, $15: **Howard Greene,** New York, "Motor Drive for Bench Lathe Takes Up Little Room" (see page 118).

SECOND PRIZE, $10: **Ernest Bade,** Glen Head, N. Y., "Taking Microphotographs without a Microscope" (see page 104).

Flying over the Ice Is Novel Sport for Skaters

By Dale R. Van Horn

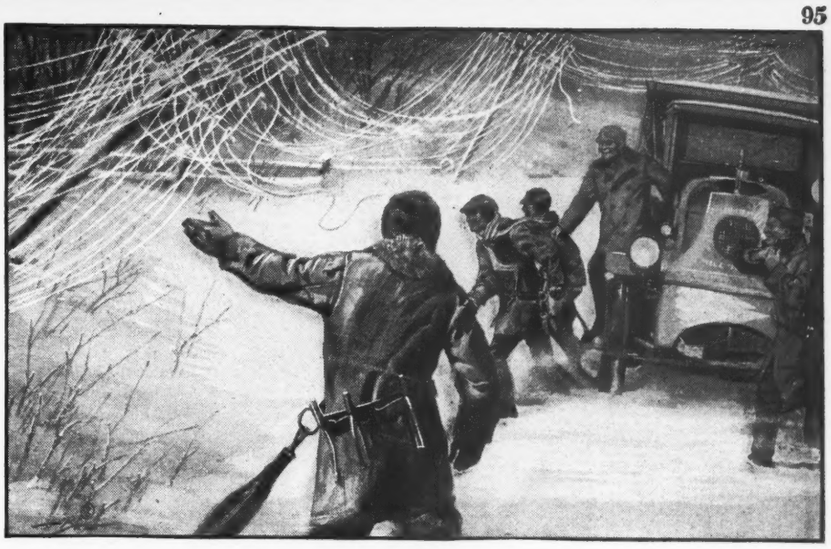
WHEN the natural setting permits, skating parties can be enlivened by arranging an overhead trolley for what might be called ice flying. One skater at a time skates rapidly toward the pulley bar, as illustrated, grasps the handle and coasts as far up the wire as possible, and then turns in midair, so that as he travels back to the starting point, he will be ready to release the bar and resume skating.

To set up the cable it is necessary to find two tree branches that overhang the ice, about 75 yards apart. One branch should

An aerial trip requiring nerve and skill

be within 8 or 9 feet of the ground, the other 25 or 30 feet. To them fasten securely the ends of a very heavy wire or light steel cable.

The car is a light wooden or steel grooved pulley wheel 5 or 6 in. in diameter, a 20-in. length of 1-in. gaspipe, a tee coupling, and two 4-in. lengths of 1-in. pipe. One end of the long pipe is split for 4 in., the halves are flattened and spread to form a bearing for the pulley spindle, which is a ⅜-in. bolt. The lower end of this pipe is threaded for the tee coupling, into which the handle pieces are screwed.



Whatever else may fail

Linking city, village and farm, crossing mountain and wilderness, the telephone system challenges Nature in her strongholds and battles her fiercest moods.

Out on his lonely "beat" the telephone trouble-hunter braves the blizzard on snow-shoes, body bent against the wind, but eyes intent upon the wires.

North, south, east, west—in winter and summer, in forest and desert—the telephone workers guard the highways of communication. Traveling afoot where there are no roads, crawling sometimes on hands and knees, riding on burros, or motorcycles, or trucks, they "get there" as they can.

When Nature rages to that point where few things can stand against her, when property is destroyed and towns cut off, the telephone is needed more than ever. No cost is too much, no sacrifice too great, to keep the wires open. If telephone poles come down with the storm, no matter how distant they may be, no matter how difficult to reach, somehow a way is found, somehow—in blizzard, hurricane, or flood—the service is restored.

Whatever else may fail, the telephone service must not fail, if human effort can prevent it. This is the spirit of the Bell System.

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19.00 A Battery, 80 amp. 6V	11.45	1.50 Multi Jack	1.15
14.50 A Battery, 60 amp. 6V	8.75	1.50 Twin Adapter	1.15
1.00 Rheostat	.32	1.25 Universal Plug	.75
.75 High Quality Dial	.20	.70 Open Circuit Jack	.60
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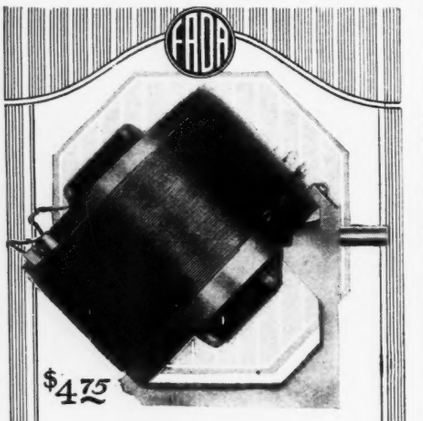

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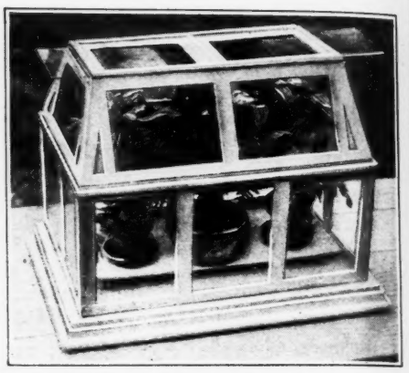
THE HOME WORKSHOP

Miniature Greenhouse Made of Wallboard and Glass

TO THE lover of flowers this miniature greenhouse will make instant appeal. It is not only easy to make and attractive in appearance, but also, with its aid, the most delicate plants can be kept in the window garden successfully. Even orchids, those fairylike flowers, do well in this greenhouse, and other plants, like ferns and palms, develop prolifically.

The material necessary for constructing this ornamental glass house are two or

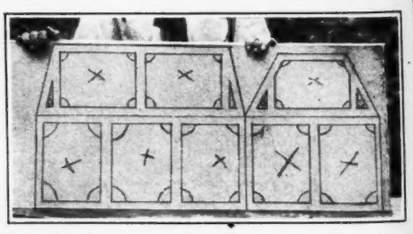


The finished greenhouse with two upper plates partly pulled out to air the plants

three sheets of wallboard or thick cardboard known as binding board, glue, tape, old photographic glass plates, a piece of galvanized screen, and wood from a box or two. The tools required are a chisel, hammer, knife, and metal shears. In addition to this, linseed oil and white lead or any other oil paint are needed.

The first consideration is the size of the old photographic glass plates that are available. The size used was 6¼ by 8½ in., although smaller or larger plates can be used. For this size, three layouts were required, two for the sides, and one for the top. The thick binding board was used for this purpose.

The shape of the finished house is drawn upon the cardboard as shown in the photograph. The larg-



How the frames are laid out on wallboard or binders board. All the sharp corners are cut with a chisel

er rectangular pieces of cardboard, which are about ¼ in. smaller than the glass plates, are carefully removed from the sheet, the corners being chiseled so as to get clean, sharp edges. Then, with a sharp knife and a ruler, these pieces are cut away.

When this has been accomplished, the three pieces are assembled and the edges

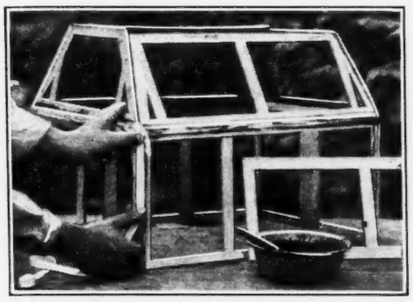
(*Continued on page 97*)

THE HOME WORKSHOP

A Miniature Greenhouse

(*Continued from page 96*)

glued together with hot carpenter's glue and tape. It is advisable to glue all edges. Narrow strips of binding board are cut and glued vertically and horizontally on the bottom, in the center, and on the sides, to provide for the thickness of the groove that later will hold the glass in place. Over these strips another face, the exact size of the original frame, is glued. The narrow grooves thus provided allow the glass to



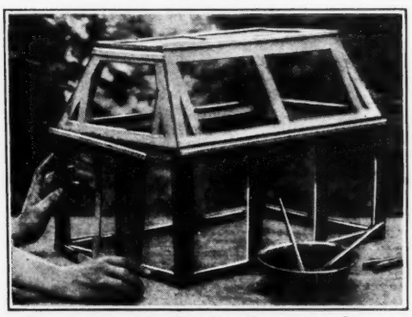
The framework sections are fastened together with carpenter's glue and tape

slide easily so that the panes can be cleaned or replaced when accidentally broken.

As soon as the glue is dry, the whole cardboard frame is loosely fastened to a board and thoroughly painted with linseed oil. This process must be repeated again and again until no more oil will be taken up by the binding board. Then the whole frame is given two coats of white lead.

In the meantime, two things are to be accomplished. One is to make a small bench fitting loosely under the greenhouse and containing two or more shelves, depending on the size of the flowerpots to be placed on it. The other is to prepare a strong, serviceable baseboard provided with a conventional molding. These parts should be painted or stained, as desired.

It is, of course, obvious that one or more of the glass plates can be removed and a



Face pieces similar to the main frames are glued on to complete the glass grooves

piece of screening, similar in size, substituted when weather conditions so require. Otherwise, one or two of the plates are partially pulled out to give the plants fresh air.

The advantages derived from this miniature greenhouse are many. Not only can seeds be sown under its cover, and ordinary house plants brought to flower, but also many beautiful but delicate plants can easily be cultivated.—E. B.

A CURTAIN spring makes a good emergency fan belt for an auto and I am always very careful to carry one in case a roadside repair is necessary.—C. J. WATTERS.

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Bed Tent Brings Comfort to Outdoor Sleeping

*[This bed tent was designed by a World War veteran who is a "T. B." patient and has been used by him for two years.—*THE EDITOR.*]*

THOSE who like to sleep with the windows wide open or are forced to do so because of illness, find that many disadvantages are involved. Rooms get so cold that it is most uncomfortable to dress in the morning, hot water heating systems freeze, and there is a considerable waste of coal in heating up the room for daytime use. The bed tent illustrated does away with these discomforts. The construction

is such that the whole outfit can be taken down in a few minutes and stored away.

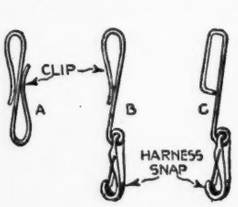
The tent is held to the window and window frame by awning buttons. The bottom edges are loaded with lead so that they will cling to the bed and prevent cold air getting into the room.

A distinct advantage lies in the celluloid window, because the occupant can see without having to lift the tent. The two upright supports are 1-in. angle irons clamped to the bed frame with wingnuts. Eyelets are provided at the inside upper corners of the tent and harness snaps are fastened to them. These snaps engage coilsprings attached to the upper ends of the angle irons for the purpose of keeping the tent stretched and out of the sleeper's way.—GERMAIN CARON, Quebec, Can.

This Key-Clip Stays Put

HAVING lost two valuable bunches of keys by having the clip work off the belt, I set out to design a clip that would not come off and yet would be convenient to use. Finally I hit upon this clip.

I took an ordinary clip, *A*, cut off one end, and bent it around a small harness snap, *B*. Then I bent the other end to fit over the belt, as at *C*. The belt must be threaded in the slot.



On one occasion this arrangement withstood a strain that stretched a key ring into a straight wire. In making the clip, care should be taken to have the loop that fits over the belt and the snap on the same side. In this way the snap is easily reached. The clip part, when caught, pulls down the belt.—E. V. C.

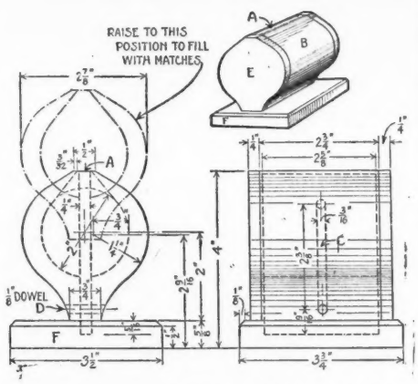
THE HOME WORKSHOP

Unique Match Safe Supplies One Match at a Time

By Harry R. L. Chellman

A UNIQUE and useful automatic match safe may easily be made by following the details in the accompanying illustration.

Any kind of wood may be used, either hard wood, such as oak, maple, and birch; or soft wood, such as mahogany, poplar, and white pine. First, cut a block 2⅞ in. wide, 3⅜ in. thick, and 2¾ in. long for the body, *B*. Make the 2-in. hole indicated by the dotted circle in the end view with a 2-in. expansive bit, or use a smaller bit and gouge the hole to the size and shape indicated. Then cut the outside to the desired



Details of an automatic matchbox, which is made entirely of wood

shape and saw the piece in half. Plane the two sawed faces to dimensions.

Make the base *F*, the two ends *E*, and the center partition *A* according to the drawings. A groove is gouged in the top edge of the partition to retain one match, and a slot is cut as at *C*, to engage the dowel *D*. Sandpaper all parts.

In assembling, fasten the end pieces with brads, leaving just enough space between the two halves of the body for the partition *A* to slide freely, without too much play. Next, fasten the partition in the mortise in the base *F* with glue and brads. Put the parts together and insert the dowel through the slot *S*. Stain and polish as desired.

To fill the receptacle, raise the body *B* to position shown by the dot and dash line and drop the matches through the slot. To operate the match safe, simply raise body *B* and lower it again to original position. This deposits one match in the groove.

Gaging Internal Threads

THE home mechanic often is obliged to find the pitch of internal threads in small tubes, machine parts, and fixtures of one kind and another. The ordinary external thread gage of the leaf type is of no assistance in cases when the leaf is too large to enter the threaded bore. Sometimes a male screw can be found that will fit and then its thread can be gaged, but if not, the difficulty may be overcome by whittling a piece of soft wood to a diameter small enough to allow it to be screwed into the tube. When it is unscrewed, an impression of the thread will be left upon it sufficiently clear to allow it to be gaged with the external thread gage.—C. M. WILCOX, Torrington, Conn.

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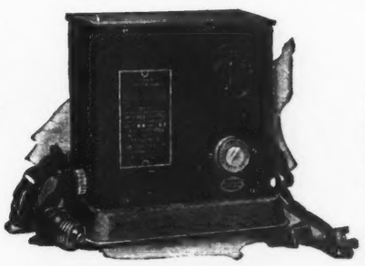

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By Charles L. Miller

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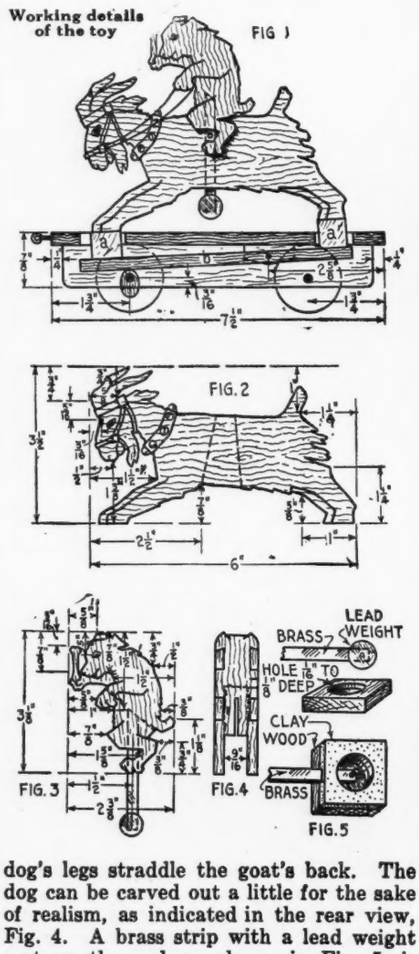
and down, but the dog always maintains his balance.

First, saw out the goat with a coping or jigsaw, from a piece of wood, ½ by 3½ by 6 in., Fig. 2. Then make a slot ⅛ in. wide through the body of the goat, as indicated by the dotted lines in Fig. 2. This can easily be done if several ⅛-in. holes are first drilled through the piece.

The dog, Fig. 3, should then be cut from a piece of wood, 1 by 2⅜ by 3⅛ in. This is a thicker piece than the goat because the



dog's legs straddle the goat's back. The dog can be carved out a little for the sake of realism, as indicated in the rear view, Fig. 4. A brass strip with a lead weight cast on the end, as shown in Fig. 5, is passed through the slot in the goat's body

(*Continued on page 101*)

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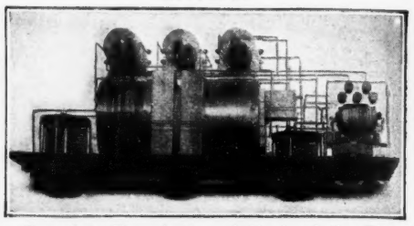

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Billy and Fido Toy

(*Continued from page 100*)

and is inserted in a slot in the dog's body, and fastened with two brads. Another brad through the goat's body and the brass strip, shown in Fig. 1, serves as a pivot, so that the dog's body will swing freely just over the goat.

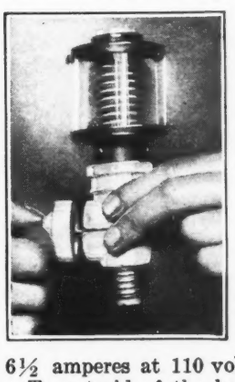
The goat is fastened to 2 blocks (Fig. 1, *a*), ½ by ½ by ⅝ in., that, in turn, are attached to a walking beam, *b*, ¼ by 1½ by 6 in., under the floor of a simple flat car. The walking beam is pivoted between blocks ¼ by ½ by 1¼ in. The platform is ¼ by 3½ by 7½ in., and the side pieces, ⅜ by ⅝ by 7 in. The wheels are wood button molds 1½ in. in diameter, with axles made from 3/16-in. dowels. To the front axle is attached a cam block to raise and lower the walking beam.

Resistance Unit for Recharging Radio Storage Battery

By J. M. Rolston

A PORTABLE resistance unit, like the one illustrated, for charging radio storage batteries from any direct current lighting socket permits the owner to draw six amperes without using a cumbersome bank of lamps. The construction is exceedingly simple and inexpensive because standard parts are used.

I was led to develop this unit because of the impossibility of purchasing resistance wire in small quantities in the open market.



Finally I discovered that a heating element in long cartridge form was being sold for basin-shaped, reflector-type electric heaters. The wire is wound on a fireclay tube and has a screw base. I purchased one for $1.25 and found by actual test that it passed 6½ amperes at 110 volts d.c.

To get rid of the heat as quickly and safely as possible, I screwed the cartridge into a porcelain extension socket with a side tap and surrounded it with a heavy glass cover from an engine sight feed oil cup. The glass was held by two fixture globe brackets, the one next to the socket being fastened in position by a brass collar just large enough to slip over the base of the resistance unit and held in place by three No. 10/32 setscrews.

The side tap extension receptacle is taken apart by loosening a screw in the base, and one of the side taps is separated from its connection with the main line, but left attached to the shell by a screw so that it will be in series instead of parallel with the main line. When a cord from the radio battery is plugged into the tap, the circuit is complete.

Only one precaution is necessary—to mark the side plug points so that the same blade will always be plugged into the same hole. Test the battery leads for polarity the first time the unit is used.

The oil cup glass costs 33 cents, two fixture holders, 5 cents each, and the porcelain extension 50 cents, making a total of $2.18 with the resistance unit.

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THE HOME WORKSHOP

Radio Receiving Set Operates on 110-Volt Direct Current

By Arnold Holmes

TO THE majority of radio experimenters, audion receiving sets spell storage batteries, which are always expensive and must be charged frequently. The wireless fan who has spilled acid from his battery on a rug and has found it necessary to buy B batteries frequently, can avoid all his difficulties if he has access to 110-volt direct current mains, for he can build a receiver to operate entirely from them.

The story of the connections of this receiver is told by the circuit diagram, Fig. 1.

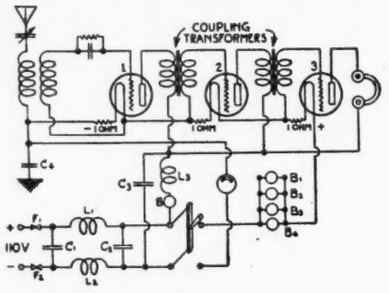

Fig. 1. Wiring diagram of set operated entirely with current from 110 d. c. mains

Any noise that is introduced in the filament circuit of the receiver by the power circuit can be eliminated successfully by the combination of coils and condensers L_1, L_2, and C_1, C_2. The condensers should each have a capacity of about 10 microfarads and can be made up of 2 microfarad telephone condenser units.

The easiest form of inductance for the experimenter to build is illustrated in Fig. 2. The core can be made up of transformer iron laminations or well annealed iron wire that has been given a covering of shellac. It is possible to obtain this wire cut to length and straightened from a steel wire company.

The fuses F_1 and F_2 should be installed for protection, and can be of 5 amperes capacity. This will protect the source of supply from accidental short circuit.

The current through the three receiving tubes, connected in series, can be adjusted

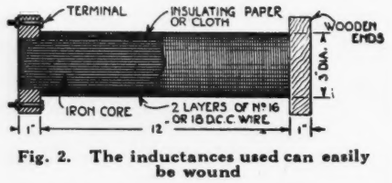

Fig. 2. The inductances used can easily be wound

to the right value by screwing in the proper number of 160-, 25-, 15-, or 10-watt tungsten or carbon filament lamps. The condenser C_4 connects the radio receiver with the ground and prevents a short circuit in case the power circuit is intentionally or accidentally grounded. The condenser should have a capacity of 2 microfarads and can be of the type used in telephone work. This condenser effectively prevents the passage of the direct current, but offers a very low impedance to currents of the frequency of the received signal.

It should be pointed out that the filaments are connected with the negative terminal of the power supply and that the

(*Continued on page 103*)

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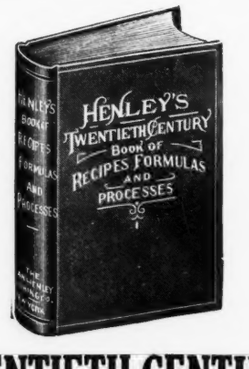

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THE HOME WORKSHOP

Radio Receiving Set

(Continued from page 102)

greater portion of the drop in potential necessarily occurs across the lamp bank.

The plate potential is obtained from the same source and in general should be made to pass through an additional coil and condenser to remove any noise still remaining. The condenser C_3 should have approximately 6 or 8 microfarads capacity and the inductance should be similar to that shown in Fig. 3. A 10-watt tungsten filament lamp is included in the plate circuit of the receiver for protection. If the plate lead is short-circuited at the receiver, the lamp lights up and the current is limited to 1/10 ampere. The lamp does not light up with a normal current taken by the receiver, and the lamp causes but a small drop in voltage across it.

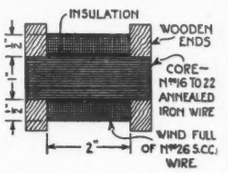


Fig. 3. Inductance for the plate circuit

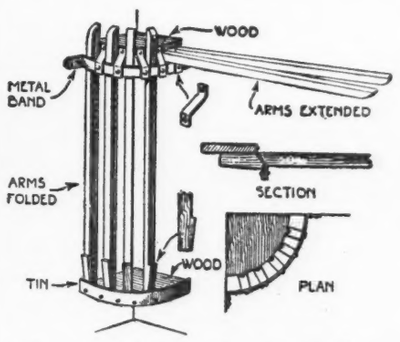
The plate potential applied to tube No. 1 is equal to the voltage of supply, say 100 volts, less the drop in voltage across L_1 L_2 L_3. That across tube No. 2 will be less than that across tube No. 1 by the amount of the filament drop across tube No. 1.

With this receiver very satisfactory results have been obtained without the expense and care of storage batteries for the filaments or dry batteries for the plate.

Neat Display Rack for Store Has Collapsible Arms

THIS collapsible display rack, installed in a Washington, D. C., store, is of especial interest because of the manner in which the arms fold out of the way when not in use so that one or more may be used independently of the others. The construction is simple and inexpensive.

The arms are shaped as shown, and the base and upper bracket are quarter sectors of a circle. These parts are all of wood. An iron band attached to the walls and the upper bracket is the support for the extended arms, which protrude in a fan shape when raised.



The arms raise up and swing out when needed; otherwise they take up little room in the corner

The rack is inconspicuous and does not take up any floor space in the store when folded. Draperies and clothes are displayed on it, but it would also be useful for hangings, wallpaper, and other materials.—G. L. K.

$500 REWARD
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In answer to a request from Chief of Police, Warren Biglow, the Finger-Print Expert arrived at the scene of the daring robbery of the O——Company offices. $6500.00 in currency was gone. Not a single clue had been found.

Almost immediately Biglow turned his attention to a table which had been tipped up. The glossy mahogany showed an excellent set of finger prints. *The thief might just as well have left his calling card.*

To make a long story short, his prints were photographed, and matched with those of "Big Joe" Moran, a safe blower. Moran was caught and convicted on Biglow's finger print proof. The money was recovered and a $500.00 reward given to Biglow, in addition to his fees—as pay for his two hour's work.

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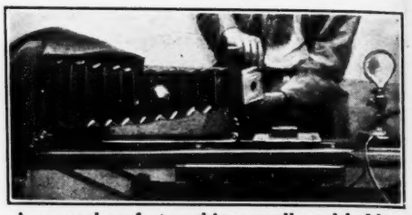
THE HOME WORKSHOP

Taking Microphotographs without a Microscope

By Ernest Bade

THE past few decades have seen an amazing development in the manufacture of lenses suitable for the compound microscope. But since such an instrument is expensive and often is employed only in photographing objects too small to be seen readily with the eye, a different method, requiring only *one* well ground lens for both enlarging and photographing, will frequently serve satisfactorily. Such a



A convex lens fastened in a cardboard holder takes the place of the camera lens

method has its limitations, however, and, although tiny objects can be photographed, they can not be magnified indefinitely.

Sections through the stems of our common woods and shrubs, which give us an intimate glimpse into their structure and function, as well as many marvels of the animal world, can readily be photographed. Insects, such as dragonflies, bees, grasshoppers, and flies, can be taken so as to show that they have compound eyes made up of six sided elements, while crayfish, which belong to the same phylum, have compound eyes consisting of four sided elements. Then, too, the brightly colored butterfly wing defines itself into numerous overlapping scales, every one of them most delicately fluted and ribbed.

Mounting the treated object

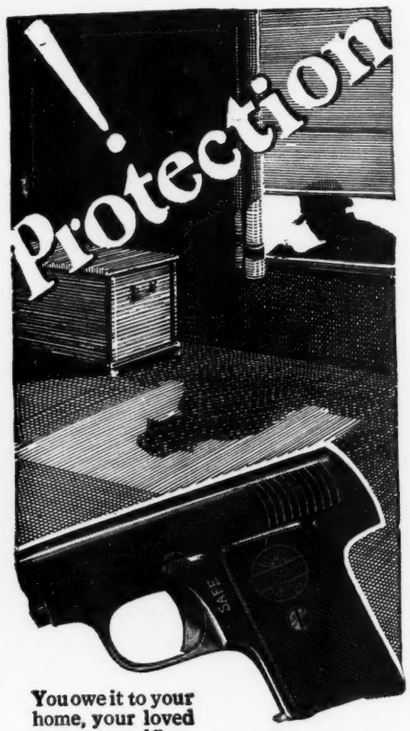
These structures, as well as countless others, can be cut with a razor and examined by the method to be described, provided the object is placed successively in 30, 45, and 60 per cent alcohol, stained, if necessary, in eosine, carmine, or aniline; and, finally, treated in 95 per cent and absolute alcohol. The object must remain at least two hours in each solution and then be hardened in xylene for the same length of time.

The object is then ready to be mounted. It is placed on a glass slide, carefully covered with a drop of Canada balsam and a glass cover gently lowered upon it so that air is excluded. It is placed horizontally and slightly weighted until the balsam has quite hardened.

The finished slide

When the slide is finished, it is held upright by means of a wooden clip, the object being placed at such a height that it lies in the exact horizontal center with the lens. The character and type of lens used will, of course, influence not only the sharpness of

(*Continued on page 105*)



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Taking Microphotographs

(*Continued from page 104*)

the image, but also the magnification. Satisfactory results are only possible with an accurately ground lens; cheap ones may be used for one or two magnifications, while the best grades are necessary for enlarging from 10 to 50 or more diameters.

A double bellows is convenient, since the longer the bellows, the greater the magnification. The addition of a 1 and a 2 ft. tubular section to lengthen the bellows, is desirable. But here it must be remembered that, while the object is enlarged, the finer details, although correspondingly increased in size, are not so distinctly enlarged with a long bellows as when a smaller lens of greater magnifying power is used with a bellow extension that is smaller.

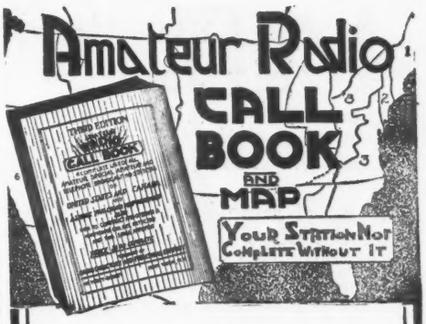
Microphotograph of vinegar fly 3/20 in. long

Various types of lenses should be tried before pictures are taken with them. After removing the plate that holds the lens, or only the camera lens, as the case may be, make a cardboard plate that will snugly fit into the vacant place. Then, taking any plano-convex or double convex lens, cut a hole in the center of the cardboard and insert the lens. Bring the microscopic object glass near the lens and focus until a sharp, clear-cut image is thrown on the ground glass. If the image is at all foggy through interference colors, reject the lens and try another. This is of fundamental importance, for good photos, clear to their least detail, can be secured only when the lens throws a clear image upon the ground glass. Then, too, the diameter of the lens should be larger than the diameter of the object or at least the same size; when the lens is smaller, only a fragment of the object can be taken.

Part of peacock fly wing 15 mm. long

It must not be forgotten that the camera lens is *not* used; a perfectly ground convex lens is all that is required. The light of a strong lamp is thrown from the back through the object, into the lens, to the ground glass. The exposure, which varies with the illumination, is a short one, a small piece of cardboard being held in front of the lens just before the picture is taken to cut off the light. The cardboard is removed to expose the plate and put back to cut off the light, the shutter then being replaced in the plate holder.

SLAG from blast furnaces is a cheap and useful aggregate for concrete. It should, however, be properly air-cooled and aged.



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The New Edition of the AMATEUR RADIO CALL BOOK is the most complete directory of amateur stations published to date — listing **Amateur, Special Amateur and Telephone Broadcasting Stations of the United States and Canada,** also describes the Construction and Operation of a Honeycomb Coil Set, Detector and Two Stage Amplifier.

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Small Current—Big Job!

Care in Selecting Your "B" Battery Cures a Whole Flock of Static Troubles

A lot of radio bugs are missing a good bet when they fail to give the proper attention to the "B" Battery that supplies current to the plate circuit of the vacuum tube. In a good many cases—and this applies to the seasoned enthusiast as well as the newest novice in the ranks—it is wrongly set down that since this current is so exceedingly small it cannot be very important.

Nothing could more completely misrepresent the facts. True enough, the current supplied by the "B" battery to the plate circuit is small—but it is precisely for that reason that even the slightest variations or disturbances are to be so carefully avoided.

In thinking of "B" batteries keep this in mind: The current from these batteries goes directly into the fine windings of the coils of your phones. Therefore even the slightest disturbance or unbalancing of the battery is translated directly into noise.

Obviously the reason for carefully soldered connections, loop aerials, short leads and the elimination of useless wires is to do away with *noise* just as far as possible. The same reason should dictate the careful selection of "B" batteries. It hardly pays to go to a great deal of trouble in taking the usual steps to eliminate static unless you also pick out a battery that is free from the hissing, sputtering and frying noises that are so often confused with static and that in common with static noises are multiplied six or seven times with each stage of amplification.

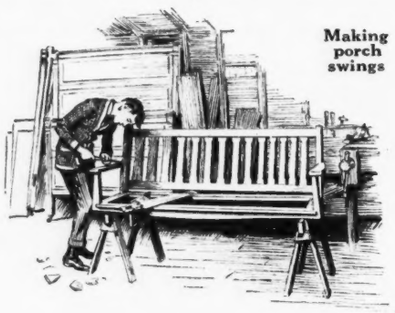
A "B" battery that is completely in accord with the efforts of manufacturers of sets to do away with static disturbances is known as the Willard "B" battery. This battery consists of a group of twelve glass-jar cells, assembled in oak cases and connected with heavy burned-on connectors. Due to the distance between jars electrical leakage from one jar to the next is practically impossible. As each of the cells has Willard Threaded Rubber Insulation between the plates there is no opportunity for leakage from plate to plate.

It is said by those who have carefully examined the construction of the Willard Radio "B" battery that, in addition to its ability to give results without distracting noises, it will last—if not a lifetime—at least such a long period that it will show a material money saving long before it begins to exhibit even the slightest sign of age. —(Advertisement.)

THE HOME WORKSHOP

How I Made Money with Odd Repair Jobs

I ALWAYS have had a shop in which to putter and tinker at making things, and when I needed money to build a wireless set, I turned to my tools to help me earn it. I found a demand for some one who would do little things that didn't require a carpenter—placing an extra bolt on a door, making a sidewalk, building and repairing fences, placing a board on a porch floor, and similar jobs. If any lad of high school age



Making porch swings

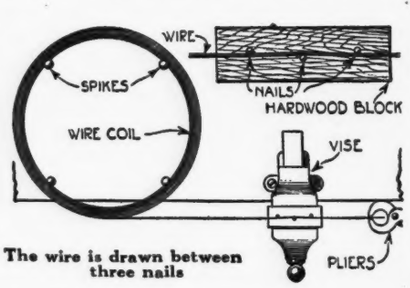
will look for this sort of work, he will find, as I did, that soon he will have more than he can handle.

Noticing that there was a demand for porch swings, I began to make them. I needed a quantity of thin oak paneling and in my frequent visits to a second hand store, I noticed one day a number of old wooden bedsteads. The proprietor said there was no sale for them, but that he had taken them in with the furniture from an entire house. Those beds looked like porch swings to me, and when I found out that he wanted only from 25 cents to $1 each, I bought the lot. I got two swings, worth $6 apiece, from each of the three frames, which also gave me paneling for chests, instrument boards, and other things of that kind.

The fact that I was able to earn money in this way kept me in high school and later allowed me to enter college, while the experience gained makes me practically independent of carpenters or repair men. —BENJAMIN B. DAWSON, Wichita, Kan.

Straightening Springy Wire

OFTEN wire, such as copper-plated spring wire and piano wire, which come from the factory in coils, must be straightened before it is used. A way to do this easily and quickly is by drawing



The wire is drawn between three nails

the wire off the coil through three nails driven in a block of hard wood.

The coil is placed over three or four spikes driven into the bench top, and the wooden block is held in the vise. The end of the wire is then threaded through the nails as shown. End-cutting pliers are used to draw the wire through.—M. F.

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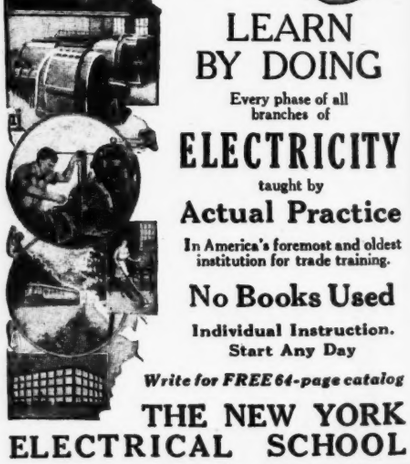

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THE HOME WORKSHOP

Test Lamp Prevents Burning Out Costly Vacuum Tubes

EVERY radio fan who experiments with new circuits can avoid the danger of burning out an expensive vacuum tube through short circuits if he will make it a practice to test the filament terminals of all sockets with an ordinary electric light bulb of the same voltage as the vacuum tube. Thus, when using a UV 200 tube, the test lamp is simply a 6-volt flashlight bulb.

If the wiring has become deranged or any mistake in the connections has been made,

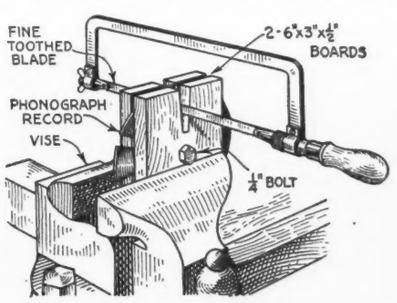
Testing circuits with flashlight bulb

the test bulb, costing only a few cents, is burned out and not a vacuum tube. The rheostat should be tested at the same time, running the slider all the way around to see that there is nothing defective with it.

To mount the test bulb neatly, use an old vacuum tube base. Break the glass away and remove everything but the filament leads, which are then connected with the terminals of the small socket, as shown. The socket and base are molded into one unit with tar or other sealing compound. —THOMAS E. MILLER, Nashville, Tenn.

Slotting Phonograph Records

ANY one who has tried to saw slots in a midget phonograph record or a piece of a large record in order to make spider web inductances for a radio set, knows that it is next to impossible to avoid breaking the brittle composition. The work can be



done easily, however, if two ½-in. boards, 3 by 6 in. are clamped together, a ¼-in. hole drilled through their center and a notch sawn in them the exact shape and size of the notches that are to be cut in the record and located properly in relation to the hole.

The record is clamped between the pieces in a bench vise and a sharp fine-tooth hacksaw is used. The sawed edges should be slightly rounded with a file so that they will not cut the insulation on the wire.—EDWIN J. BACHMAN, Fullerton, Pa.

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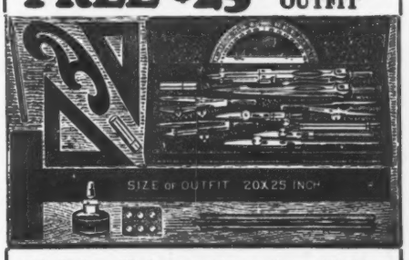

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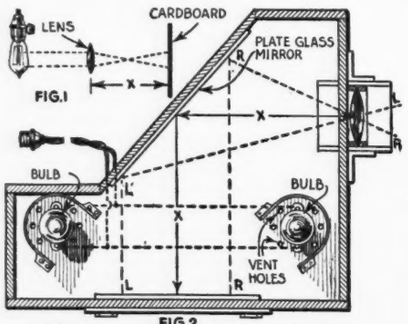
Postcard Projector Does Not Turn Views Backward

MANY postcard projectors show the pictures backward, with the printing reading from right to left, although some of the higher-priced machines use a prism and refracting lens to correct this fault. You may make a projector having this advantage, however, without using a prism and at very little expense.

Any reading glass will serve as a lens. Find its focal length by holding the lens between an electric light and a sheet of white cardboard, as in Fig. 1. Move it back and forth until the filament of the light is clearly defined on the cardboard, and then measure the distance between the lens and the cardboard; that will give you the actual focal length.

The box part is made of 7/8-in. wood, all the cracks being thoroughly puttied. A



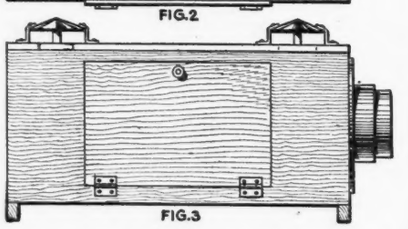


Fig. 1 shows method of testing focal length of lens; Fig. 2, the projector with top removed; Fig. 3, the side view

door on the back is hinged at the bottom. The construction should be such that there is a flange over the opening, so that no light will leak out when the door is closed. A metal clip is fastened to the inside of the door to hold the picture in position (Fig. 7). Two receptacles for 75-watt electric lights are placed so that with the aid of reflectors all the light is concentrated upon the door. The reflectors are cut from thin sheet aluminum or tin and bent as shown in Fig. 6.

Directly in front of the door is a plate glass mirror, set at a 45-degree angle (Fig. 2). The dimension *X* is the focal length of the lens. Opposite the glass on one side is the projecting sleeve, the outer part being fastened on the outside of the box by means of a square plate (Fig. 5). This sleeve can be made from an old tomato can. A tube containing the lens slides inside of this sleeve; another tin will serve for it. The lens is held in place by two rubber ring washers (Fig. 4).

Holes are cut into the top above the lights and over them are fixed small ventilator hoods (Fig. 3). They can be made from pieces of galvanized iron cut in the shape of 340-degree arcs and rolled into cones. Brackets for fastening the hoods to the box can be made from the same material and

(*Continued on page 109*)

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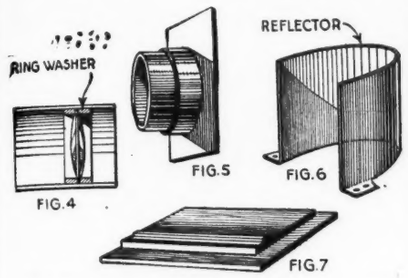
THE HOME WORKSHOP

Postcard Projector

(*Continued from page 108*)

riveted to them. In the bottom, around the lights, holes are cut to admit air, because when the lights are burning, they give off considerable heat and must be properly ventilated. Both lights are connected with one drop cord, as shown in Fig. 2, and the plug is screwed into an electric light socket.

A bed sheet may be hung on the wall to serve as a curtain. Place the projector on

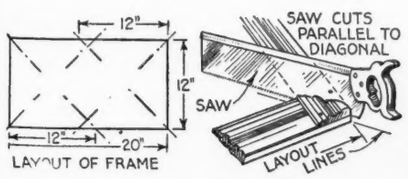


Details of lens mounting, reflectors, and picture holder on inside of door

a table or stand and move the tube that contains the lens in and out until the view of a card in the holder appears upon the screen bright and clear. The card should be placed in the projector upside down and the mirror then catches the view and reverses the left to the right, so that when the lens picks up the picture, it reverses it back to normal on the screen. In Fig. 2, page 108, *L* signifies left and *R* right. A projector of this type will work with photographs, pen and ink drawings, or any other printed matter.—EDWIN G. GETTINS.

Rough and Ready Method for Making Mitered Frames

OFTEN when the home mechanic wants to make a picture frame or other mitered frame, he has no miter box handy and doesn't wish to go to the trouble of making one. He can make perfect fitting corners, however, simply by laying out on the workbench or table the outline of the outside dimensions of the proposed frame, as shown. Measure along the two long sides a distance from the corners equal to



Lines laid out on bench take the place of miter box

one of the narrow sides. From these points draw diagonal lines through the corners of the rectangle to represent the lines of the miter.

One strip or piece of molding is placed on the table and another piece is laid on the top of it at right angles. Then both pieces are alined on the layout and fastened together with small sprigs. By holding the saw parallel to the mitered line, a perfect cut may be made through both pieces. The process is repeated in each corner and no mistakes in size or squareness are likely to occur.—M. L. E.

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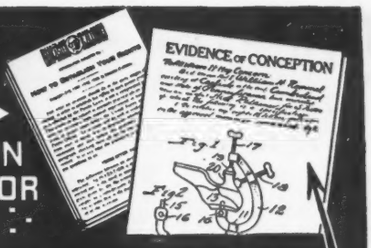

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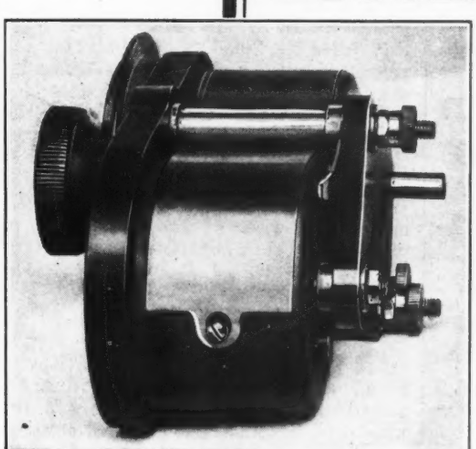

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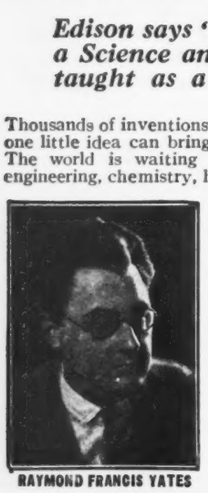

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(Continued from page 24)

were tried in an effort to stop this phenomenon of induction. Queer, mysterious instruments were hung on the poles or connected in the circuits. Some of them not only killed the induction, but they killed the voice currents as well.

Just at the juncture when those assigned to the problem were about to give it up, one of Carty's men tried the simple expedient of twisting the two wires of a circuit about each other. It worked! Troublesome induction was eliminated and the telephone company was enabled to extend its lines a little farther.

These extensions, however, presented other new problems, one of which was the iron wire, which had been borrowed from the telegraph. A long distance line, built from Boston to New York, was found to be practically unworkable because of the extremely high resistance of the iron wire to the telephone currents. All sorts of iron and steel wire were tested, but to no avail. Experiments with other metals proved that copper was best. But the copper wire then available was so soft that when lines were strung, the copper stretched and broke under its own weight.

First Hard Drawn Copper Wire

As usual, one of Carty's men came to the rescue with the idea that copper might be drawn into a hard wire. This man was sent to a Connecticut wire factory where, after a series of experiments, he produced one of the fundamental contributions to modern communication—the hard drawn copper wire. This wire combined the electrical advantages of copper with the strength of iron, and at the same time it eliminated the rusting of wires.

The one drawback to copper wire proved to be its high cost—four times as much as that of iron. In some instances, on long lines, it was necessary to use wire as thick as your finger. The first line between New York and Chicago (a single circuit), for instance, weighed 870,000 pounds and the cost of the bare metal was $130,000! How might this cost be reduced?

Carty and his staff supplied the answer by discovering better kinds of insulation, by making telephone instruments more sensitive, and by the use of a new invention called the "loading coil," all of which permitted smaller sizes of wire. The invention of the so-called loading coil, which eventually made transcontinental telephony possible, came from outside the telephone industry. It was the work of Michael J. Pupin, professor at Columbia University, and it saved as much as $40 for each mile of wire.

Early Days of the Switchboard

In 1885 began the development of the modern switchboard. The first switchboards, like other parts of the first telephone system, were borrowed from the telegraph. They connected only a few hundred customers, but occupied as much space as the modern switchboards, where one girl can now make connections between any two of 10,000 subscribers.

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(Continued on page 111)

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(*Continued from page 110*)

ing rate—so alarming, in fact, that at one time the general manager of the New York office actually prepared figures showing just how many new subscribers would be required to throw the company into bankruptcy! Sometimes a single switchboard would cost several millions of dollars.

Again it was up to Carty and his coworkers to find a remedy. And they found it, but through the slower, surer course of scientific research. Under his guidance one new type of switchboard after another was devised and tested. Long before one switchboard wore out, it was replaced by improved apparatus.

Machines that Seem to Reason

Deliberately, each small step in the progress of wired communication led surely to the crowning achievement of the modern telephone — the automatic switchboard, with which a telephone user can make his own connections without the intervention of any other human hand or brain. These marvelous automatic machines not only make connections between two parties on the same exchanges, but select "trunk" lines between exchanges that are not busy. They operate coin box stations with accuracy as to charges, returning coins, and perform with accuracy a hundred other functions that a telephone operator can perform only after a long course of training. They are now being installed in all parts of the country as rapidly as they can be manufactured and put in service.

Still another problem solved by Carty's telephone engineers, was the underground cable. When the telephone was young, wires were strung along the housetops. Soon this plan had to be abandoned and the wires were put on poles. But in the cities the pole lines became so crowded that it was practically impossible to string more wires. Finally, legislatures and city councils began to demand that the wires be taken down and placed underground.

Of course, it was possible to bunch the wires in cables and put them underground, but they wouldn't work there. Difficulties of transmission were increased a hundredfold. Induction and resistance at once became so great that it was easier to talk over 100 miles of open wire line than over one mile of cable.

Evolution of the Cable

At first the wires of the cable were embedded in rubber, and while rubber was a good insulator for most purposes, for some reason it destroyed the delicate voice currents. To quote Carty:

"Cable was expensive; the distance over which one could talk was limited, and nobody knew what to do about it. As early as 1881 I participated in experiments in which all possible types of cables we could think of were put down. The first big advance was the introduction of cotton insulation in the cables instead of rubber. The cotton cable was very greatly improved and finally it was superseded by the paper cable, in which each wire is wrapped loosely with paper. The paper cable has gone through a process of evolution until today we have cables no larger than your wrist carrying 3000 wires, and our cable

(*Continued on page 112*)

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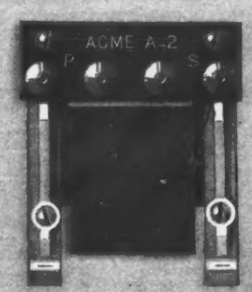

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(*Continued from page 111*)

lines extend from Boston to Washington, and from New York halfway to Chicago. There is now no physical difficulty in the way of cables from coast to coast,"

In spite of all these remarkable developments, it would still be impossible to send weak telephone currents across the continent and receive them with sufficient strength to be audible, were it not for the invention of the telephone repeater. The function of this ingenious instrument is to pick up the weakened telephone current at a point along its route, strengthen it, and send it on to the next section of line.

The average radio amateur will at once recognize the telephone repeater as the familiar vacuum tube amplifier. That is exactly what it is, although it is not generally understood that the vacuum tube was developed in the telephone laboratory.

Original Use of Vacuum Tube

When Dr. Lee DeForest invented his vacuum tube, Carty and his staff were the first to see its far-reaching possibilities. Today, thousands of vacuum tubes, as perfected by countless researches of the telephone engineers, are in service 24 hours a day. A telephone conversation between New York and San Francisco is relayed 12 times through vacuum tubes, yet the voice heard at the distant end of the line is a faithful reproduction of the speaker's words!

Not only the vacuum tube, but the wireless telephone itself as a reliable means of long distance communication, was born in the telephone laboratory under the guidance of Carty. As early as 1913 Carty had set a scientific staff to work investigating the use which the telephone system might make of radio. As a result, a practical wireless telephone was developed and in one experiment with this instrument Bell engineers talked from the Arlington station to the Eiffel Tower in Paris. One engineer even picked up the conversation in far-distant Hawaii—a long distance record that never has been broken.

We have here but the barest outline of the marvels of the telephone, for there are hundreds of other devices about each of which a book might be written; for example, the phantom circuit, which makes two pairs of wires do the work of three pairs; the carrier current system by which six or seven simultaneous conversations may be carried on over the same wire; the multiplex telegraph, by which several telegraph messages can be sent over a wire being used simultaneously for one or more telephone conversations.

Today there are more telephones in New York City than in all of England; Chicago has more than France and nearly as many as Germany. With one sixteenth of the world's population, the United States has one third of the world's telephones. In this country every year there are 350,000,000 more long distance telephone calls than telegrams and 6,000,000,000 more telephone calls than communications by letter.

These achievements of the telephone would never have been realized except by the constant application of scientific research, and among the exponents of the practical value of science there is no one more conspicuous and successful than J. J. Carty.

W. L. DOUGLAS

The First Successful Color Movie

Coué's Magic Health Secrets

(*Continued from page 26*)

the simple and unspectacular act of hitting the ball straight or doing the week's work easily and right.

Prove this to yourself. You know that you can easily stand on a foot-square platform two inches above the floor—but all the will in the world could not make you stand safely on the same platform suspended in space 300 feet above the gorge of Niagara. The reason is simply that if your imagination avidly seizes on the spectacular picture of the fall in store for you, your will, unless under marvelous control, cannot prevent the unconscious from absorbing this picture, and the unconscious, through its mysterious action on the functions of your body, promptly precipitates the fall.

To apply the Coué system you need only a few brief recipes. First, you must be convinced that cure by autosuggestion is actually possible. You must have faith. The experiment illustrated on page 26, and suggested by C. H. Brooks in "The Practice of Autosuggestion"—one of the most readable explanations of Coué to be had—will convince you of the powers of the unconscious. Brooks also cites the familiar trick of telling a passenger on a ship that he looks as though he were getting seasick. His imagination is already full of the terror of this very development. Your word reinforces the terror and he succumbs. But turn to an old time seaman and tell him the same thing, and he merely laughs. His unconscious doesn't accept the idea, and the same suggestion has no effect upon him.

Is Coué's Personality a Factor?

While Coué claims no power of any kind not inherent in all of us, it is probably true that a slightly hypnotic effect, due to his personality, impresses his hearers, and so overcomes their first conscious revolt against his theory and influences the unconscious mind to accept the message he has for it. Thereafter, the whole process of cure becomes one of purely self-suggestion, that anybody can practice.

Of course, you must not expect miracles. Coué and his disciples have published hundreds of testimonials of cures for practically all the diseases that can afflict a human being. That many of the cures claimed are utterly absurd and absolutely impossible has been proved by the experience of generations of scientific observers, who have studied the very methods used by Coué and his followers.

Autosuggestion may cure only where the disease or the disorder is due to abnormal functioning of the nervous system, or to abnormal functioning of an organ, the operation of which can be influenced by suggestion through the nervous system.

All conditions that can be improved or eradicated by stimulating better digestion, assimilation and nutrition, or that respond directly to strong mental stimuli, can of course be helped by the Coué formula. But these do not include tuberculosis, diphtheria or any organic disease or acute germ infection. Germs that are alive and kicking won't pay much attention to hypnotic suggestions or even the Coué rosary string.

But science must accept the fact that functional and nervous disorders *will* often succumb to autosuggestion and that Coué's sudden worldwide fame is justified because he has brought us a novel technique for effecting such cures.

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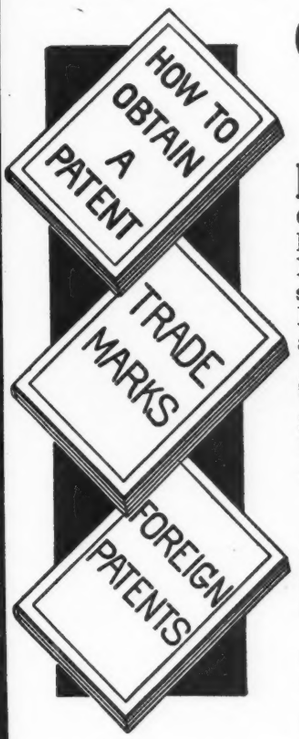

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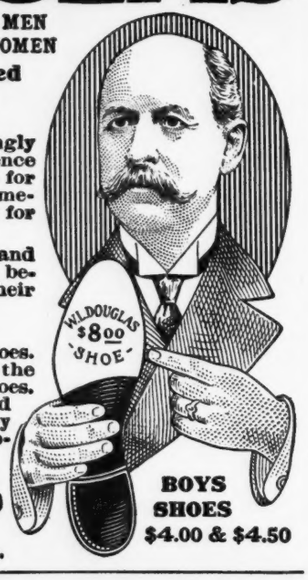

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The First Successful Color Movie

(*Continued from page 61*)

photograph made through the red-orange screen. They will not show on the other photograph. The blue parts, on the other hand, take only through the blue-green screen. Now we dye one photograph red-orange and the other one blue-green. The first represents the red parts of the dress, the second the blue parts. We put them together, one on top of the other (of course both are transparent), and we have a color photograph of the dress.

All this is simple enough, but when we come to apply it to motion pictures, there are difficulties. The greatest is to discover some way of taking two photographs at the same instant, *through the same lens.*

This problem Doctor Comstock solved in a very ingenious way. Just back of the lens of the camera he placed a silver mirror with holes in it. Half of its surface is polished silver, the other half is holes. It stands at an angle of 45 degrees to the beam of light. What happens to the light can be seen immediately from the diagram on page 59. One half of the light is reflected at a right angle. The other half goes straight on. The light beam from the lens is thus split into two beams, exactly alike. One of these beams is led through the blue-green color screen, to make the blue-green image at one point on the film. The other is led through the red-orange screen and makes the red-orange at the same instant on a lower portion of the film. Then the film moves and two new images are made again, one above the other.

The film consists, then, when removed from the camera and developed, of a succession of double pictures (one below the other) all still in black and white. One picture of each pair corresponds to a blue-green image, the other to a red-orange image. This film, of course, is a negative.

The next step is to make the positive print from this negative. On this print the pair of images taken at the same instant and that are separate on the negative must be brought together and superposed. The blue-green one of a pair is printed on the front of the positive film, the red-orange one is printed on the back of the same film. They must now be dyed.

In this process the positive film is run through one dye bath that contains in solution the blue-green dye and the red-orange dye. The dyes are taken up selectively by the two images on the film; the blue-green dye "takes" only on the blue-green image; similarly, the red-orange dye colors only that image.

The result of this selective dyeing is a colored positive print ready for projection.

Aside from the technical difficulties involved in the perfection of color movies, there remain other still more interesting problems—problems of directing, of acting, of the psychology of audiences. At present the movie actress's make-up, for instance, is a horrible looking mess of yellow cheeks and blue chin and forehead; blues for what is to be white, yellow for healthy flesh. For color movies all this must change.

An effective make up, I believe, may prove to be greenish or violet, with reds inclining to orange, instead of the yellows and blues now used. Certainly, when the color movie make-up technique is so perfected as to simulate a beautiful star's natural color of complexion, hair and eyes, we shall have more fascinating photo plays than ever.

THE HOME WORKSHOP

Box for Feeding Birds in Winter Turns with the Wind

By Robert Page Lincoln

TO ENCOURAGE the winter birds in the colder sections of the country, many persons scatter crumbs or seeds on the ground, after clearing away the snow. This is not the best method, because driving snow frequently covers the food just at the time when it is most needed. If a revolving

feed or bird box is provided, this difficulty will not arise.

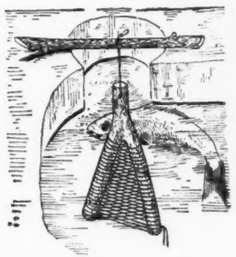
The type of pivoted box illustrated is one that has been used with success. It can be made of ¼ or ⅜ in. stock in any reasonable size. The wings are of the same material, cut as shown. The house revolves on the end of a pole that has an iron rod driven into it. A washer is used between the top of the pole and the bottom of the house.

The box should turn readily in a high wind, but not so freely that it has a tendency to spin.

A Simple Set Line Rig for Winter Pike Fishing

A THOROUGHLY reliable method of making a set line rig for fishing through ice for pike, muskalonge and other large fish, requires nothing more than a stick and crotch. The crotch is large or small, depending upon the amount of line to be used.

A hole is bored near the top of the handle and the line is pulled through, brought down to the crotch, slipped under and then wound over one arm and under the other. This over and under winding is continued until all the line is on the crotch except the length desired to hang. Thus, for fishing in 20 ft. of water, with the lure 5 ft. from the bottom, it is necessary to allow 15 ft. of line to hang free. The line is secured by slipping it into a slit cut in one arm of the crotch.



The lure is a live minnow or a 6-in. perch. It is dropped down and the whole crotch is suspended from a rod by being tied to a pole across the hole. When the pike seizes the lure, it pulls the line out of the slit; and as the fish runs, the line slowly unwinds. If there is 50 ft. of line on the crotch, the fish will be well tired out when he has taken it all off. Set lines of this sort are put out in the afternoon of a winter day and looked after the next morning.—L. R.

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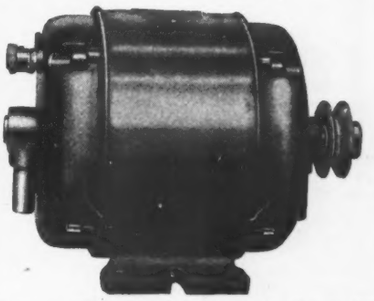

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THE HOME WORKSHOP

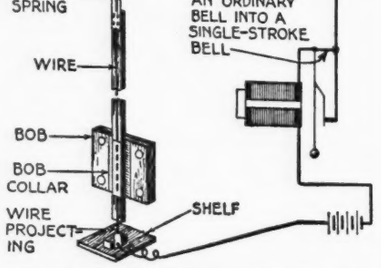
Electric Timer in Darkroom Aids Amateur Photographer

By H. C. McKay

IN ALL darkroom work the amateur photographer feels the need for some method of accurately counting time. Consulting a watch or guessing at the time are equally unsatisfactory. The ideal way is to make a simple audible counter.

The materials required are a common advertising yardstick, a 6-in. length of light clockspring, a wooden block 1 by 3 by 3 in., some tinner's lead or babbitt, wire, batteries, a large nail or spike and an electric bell.

The ends of the clock spring are annealed. Through one end is drilled a hole just large enough to admit the spike; through the other, four small holes are drilled for fastening it with screws to the yardstick. The nail is then cut down to about 3 in. long, and filed at each end to form a wedge, as shown. The piece is then soldered to the clockspring, with the sharp edge of the wedge turned down. From this fulcrum to the bottom of the yardstick should be at least 41 in. A wire is next soldered to the end of the spring, carried down the stick and allowed to project an inch or two. A sliding weight is made by boring several holes into the wooden block and filling them with babbitt and the block is fastened to the yardstick with a tin strap fitted tightly. Thin wedges may be used to fasten it in the exact position that will cause the pendulum to swing 60 times a minute.



When the pendulum is properly adjusted, the bell rings once a second

A yoke is then made, as shown, and fastened at a convenient place on the wall. A small shelf is placed just below the bottom of the wire projecting from the lower end of the pendulum. Upon this shelf is fastened a thin strip of flexible copper such as may be obtained from a field coil of a Ford magneto. This strip should extend upward, so that the swinging end of the pendulum will just touch it. All that remains is to complete the bell circuit by attaching one wire to the top of the pendulum spring and the other to the copper strip. If the bell is wired as shown, it will give a single stroke, which is desirable.

A small cup filled with mercury may be substituted for the copper strip. The surface tension of the mercury allows it to "pile up" over the edge of the cup so that the wire can swing through it. This gives less obstruction to the passage of the wire, but each swing scatters a small amount of mercury and the cup has constantly to be refilled. Another refinement is the substitution of a telegraph sounder for the bell. This is the form I use.

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THE HOME WORKSHOP

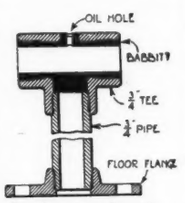
Motorizing Your Workshop

(*Continued from page 77*)

pulley arrangement for starting and stopping them. A double belt arrangement will also give a reversing pull when tapping or cutting threads.

For the general utility shop and the farm repair shop the installation can profitably be somewhat heavier, with floor machines, commercial hangers, and light steel pulleys as shown in Fig. 2, page 77. This layout for the handy man's motorized workshop provides for a saw bench, grindstone, grinder, and post drill.

Those who plan to install machinery in a basement or cellar should avoid fastening hangers to the floor beams, since the vibration will be felt throughout the house. The hangers should be attached to cleats fastened to the masonry with lagscrews and expansion shields. The hangers should be deep enough to take a pulley at least 30 in. in diameter, which obtains the speed reduction from the motor pulley.



A pipe tee beating

For the home shop, shafting 1 in. in diameter is heavy enough, and for light machinery a round belt offers one of the handiest means of transmitting power. Round belts and pulleys can be obtained in many junkyards from wornout sewing machines and the like, and often flat belt pulleys can be obtained in the same way. Cold rolled machine steel serves for the shafting, and the babbitt bearings can be cast by the builder himself.

The outfit shown in Fig. 3, page 77, is a good one for the home worker who specializes in machine work, model making, and the like. The bench arrangement illustrated provides a compact and very useful small machine shop with bench lathe, miller, drill press and grinder.

Some Hints about Machine Tables

Machine tables or workbenches can be made by the home mechanic to suit his own requirements and should be strong and heavy. If the bench is too light or flimsy, the vibration of the machine is bound to be troublesome. If possible, the bench should stand from the wall, so that the operator has access to all sides. The motor wires can be strung from the floor or dropped from the ceiling. At least two switches, one on either side of the bench, should be provided for starting and stopping the motor.

Motors up to and including ¼ hp. can be tapped off the electric light current, but ½ hp. must have a separate wire from a power circuit. A good arrangement is to have a three-way socket mounted overhead, the top of one side being used for the motor, another side for a portable electric drill, and the third side for the light.

The problem of countershafts and tight and loose belts can be avoided if one is willing to throw off the idle belts on machines that are not in use. This saves in equipment and lightens the load on the shaft.

Before buying a motor, it is well to consult an electrician in regard to the correct voltage, phase, and cycle of the power available. If electric current cannot be used, a small gasoline engine will give dependable and inexpensive power.

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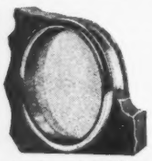

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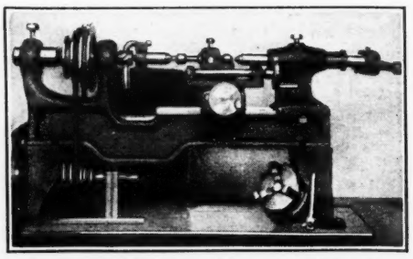
THE HOME WORKSHOP

Motor Drive for Bench Lathe Takes Up Little Room

By Howard Greene

AMATEUR mechanics like the writer are often put to it to find room for their tools and equipment, especially in the constricted space of a flat. While an old table in the corner of a bedroom has done duty as a bench, it was a problem to make a place for a diminutive lathe that was added to the outfit. The lathe itself is but 13 in. long and swings 4 in. over the bed and 5 in.



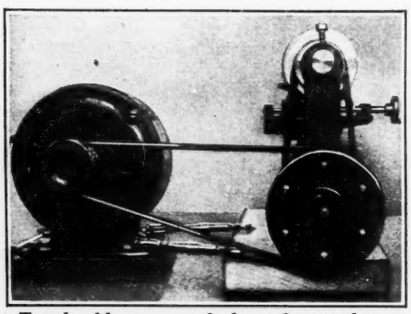
A countershaft for the motor drive is placed under lathe bed

in the gap, but there seemed no place to put a foot power drive, so the lathe had to be motorized.

Experiments were made with a number of small motors. Motors that formerly had done duty driving fans were found unsuitable because of the variable speed. Very small motors were available, having plenty of power despite their compactness, but they were unsatisfactory because of their very high speed, which necessitated a lot of speed reducing gearing.

Finally an induction motor rated at 1/20 hp. was installed. The power is exactly right, being sufficient to drive the lathe under all conditions of work, and the speed is absolutely constant at 1750 r.p.m.

The lathe was mounted on one piece of oak 1⅛ in. thick and the motor on another. The bottom of both bases was padded with



Turnbuckles connect lathe and motor bases and regulate the belt tension

heavy felt glued on. The two bases were then connected with turnbuckles set at an angle, so that the lathe and motor cannot get out of alinement. The turnbuckle also serves to regulate the tension of the round driving belt, which is 3/16 in. in diameter.

The pulley on the motor is 1½ in. in diameter and drives a 4-in. pulley on a countershaft set under the lathe bed. The three-step cone pulley on the countershaft is a duplicate of that on the lathe spindle, except that it is made of fiber disks screwed together. The outfit is shoved out of the way when not in use.

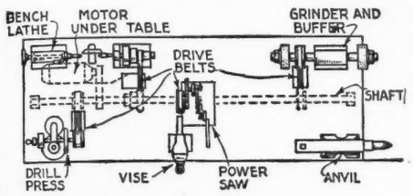
The difference in the electric light bills made by the use of the motor is so slight as to be negligible.

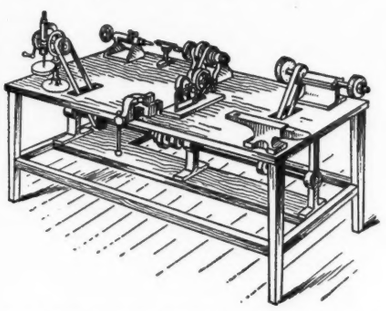
THE HOME WORKSHOP

Motorized Workshop Saves Time in Making Plant Repairs

A PORTABLE bench with a self-contained power plant is used in one large factory so that small construction or repair jobs can be done with the least delay. To obtain power, it is necessary only to screw a plug into the nearest lamp socket.

The heavy, rugged bench has a lower shelf to support the motor and a line of



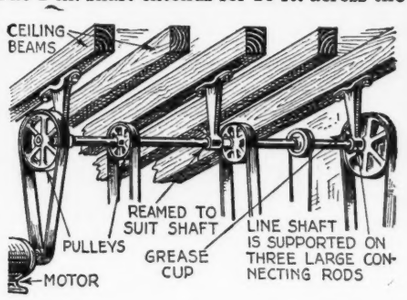


A miniature machine shop with motor and shaft mounted on shelf under bench

shafting. A drill press, a power hacksaw, a bench lathe, a combined grinder and buffer, a small anvil, and a vise are bolted to the top of the bench. The hacksaw is so placed that material to be cut can be clamped in the vise.—G. M. D.

Connecting Rods Serve as Hangers for Line Shaft

THREE large connecting rods from an old engine were utilized by a Washington, D. C., mechanic for supporting a line shaft that was to drive a series of small bench machines from a 1-hp. electric motor. The 1-in. shaft extends for 15 ft. across the



Hangers cost little to install

shop and improvised hangers are placed at 5-ft. intervals.

The large end of each connecting rod was attached to the beams with heavy lag screws and the bearing at the small end of each was reamed to suit the shaft and fitted with a grease cup. No loose pulleys are used on the line, but an electric switch conveniently located permits throwing the power off and on as required.—L. F. B.

A SMALL bench vise makes an excellent nut-cracker if none other is available and is far better than a hammer.—C. J. W.

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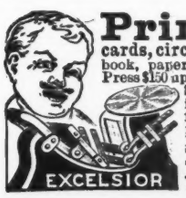

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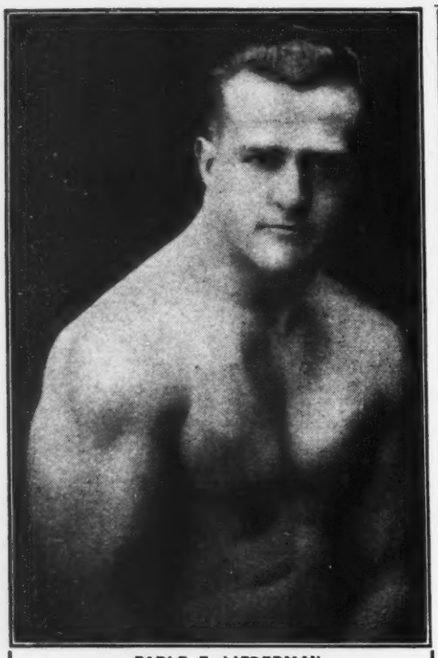

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THE HOME WORKSHOP

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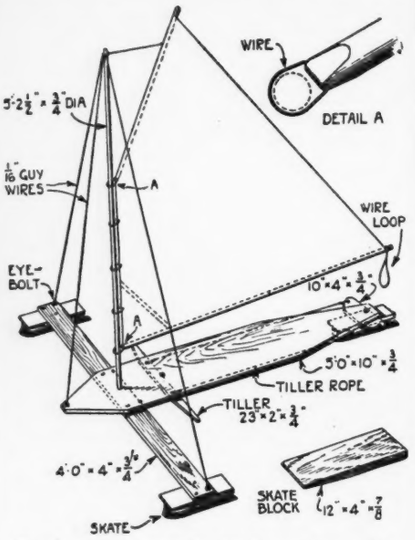
SKATES form the runners of this little ice boat, which will furnish endless fun for the skilful boy on frozen ponds and streams. The rider lies flat on the plank and operates the tiller with his hands. The sail is manipulated by means of the wire



The boat is steered by hand and the sail is regulated by foot

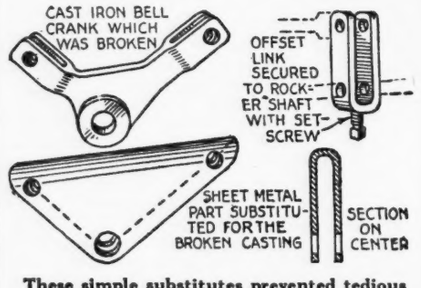
loop at the end of the boom, which is slipped over either ankle.

The sail may be lowered in the usual manner and the boat can be dismantled by folding the spars parallel to the mast and removing the mast from its socket. Hockey skates are screwed to the runner blocks. The illustration makes clear all other details.—DONALD W. CLARK.

Sheet Metal Parts Will Replace Broken Furnace Castings

FREQUENTLY some casting connected with the furnace breaks. Regulator links, draft door controls, and parts operating grates are brittle and easily damaged.

These parts can often be replaced quickly and inexpensively with sheet metal fittings. On one furnace the bell crank in the connections to the lower draft door at the rear of the furnace had been broken, but the need for a new casting was avoided by making the sheet metal substitute that is illustrated. The piece was doubled at the center and drilled for the rocker pin.


CAST IRON BELL CRANK WHICH WAS BROKEN
OFFSET LINK SECURED TO ROCKER SHAFT WITH SET-SCREW
SHEET METAL PART SUBSTITUTED FOR THE BROKEN CASTING
SECTION ON CENTER

These simple substitutes prevented tedious delay in obtaining new parts

Another repair was made by using a strip of steel and a setscrew to replace an offset link that had been connected with the rocker shaft.—L. N. O.

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Wind Drives Ice Bicycle

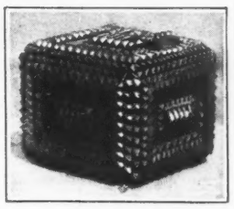
(*Continued from page 78*)

justing them where desired on the rear wheel trusses.

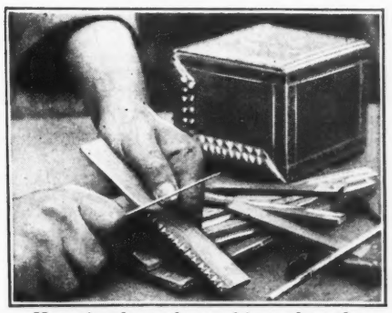
All the details of the scooter attachment are illustrated, but the materials and parts can be varied to suit the convenience of the maker. The dimensions shown are intended to meet normal needs. For racing, a larger spread of sail and narrow, grooved runners are improvements that add to the speed, but call for skill in manipulation, particularly at turns.

As a final detail, some gripping device is desirable on the rubber-tired wheel. Sash chain or very small size tire chain may be used. To apply sash chain, wrap it around and around the tire for one revolution of the wheel and then wrap it in a reverse direction to give a diagonal cross-linked surface, as shown on page 78. Small tire chain is more difficult to apply because the sections must be much reduced to suit the bicycle tire.

Carved Strips Transform Cigar Box into Jewelry Case



ORNAMENTAL carving of the simplest kind will transform an almost square cigar box into the jewel case illustrated. The carving is done on strips taken from another cigar box, some of the strips being 1 in. and others ½ in. wide. Each of the strips is then notched along its two upper sides with a pocket knife, care being taken to space the notches



How simple workmanship evolves the case shown above

equally as to depth and width. Then, when a sufficient number of strips have been cut, the wider ones are nailed along the outer edges of each side and top. Over them the narrower strips are bradded until all four sides and top are finished.

The ornamentation may be carried further, if desired, by placing notched strips or plates in the center of each side.

After being sandpapered, stained, and waxed, the box appears to be carved from solid wood.—ERNEST BADE.

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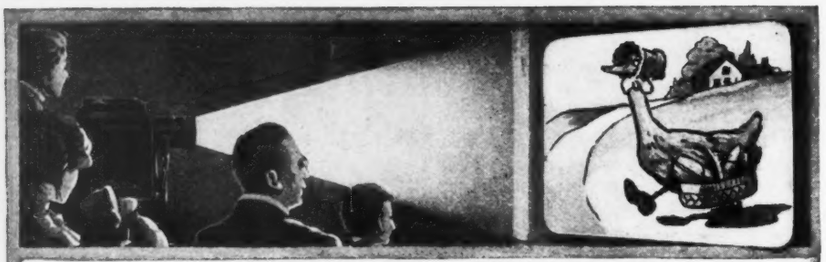

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THE HOME WORKSHOP

The Secrets of Stenciling

(*Continued from page 78*)

and original designs that do not require to be filled in with a brush.

Paper for cutting stencil should be rubbed on both sides with linseed oil and turpentine to make it tough and easy to cut, or prepared stencil boards may be purchased.

After drawing or tracing the design on the prepared paper, lay it on a glass slab and take great pains to make a clean cut and not to run past the outline of the design. This is best accomplished by using a short pointed knife, preferably sharpened on both edges, which may be bought at any cutlery store. The majority of stencil cutters, however, make their own knives to suit and often use a safety razor blade in a homemade handle, as shown in Fig. 3.

Suppose it is desired to stencil a black Greek border on a yellow flower box, as at *I*, page 78. The first thing to do is to draw the figure and determine how many of these figures, or repeats, as they are called, are required for the given field. The repeats are in black at *E*, *F* and *H*, page 78.

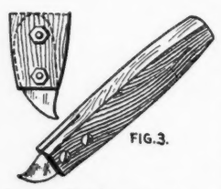

FIG. 3.

Stencil knife made from razor blade

Assume the box to be 19½ in. long, 10½ in. wide, and that the repeat is 1½ in. long; 40 impressions will then be necessary to go around the box. The work will be greatly facilitated by cutting out more than one repeat; say three, thus making the stencil repeat 4½ in. long, as at *A*. A single unit *B* then finishes the 19½-in. side. Mark divisions on the stencil, as at *G*, by drawing two vertical lines, and at the end of each line cut a V notch for locating. Trim the stencil so that it will not cut any portion of the design when applied, as otherwise, if the paint is still wet, it will blur the preceding work. It is, however, advisable to use a flat or fast drying color.

Brushing on the Color

When there is a large surface to cover, it is best to strike a center line with a piece of cord that has been rubbed against chalk or charcoal. It should be held taut at each end and snapped against the work. Also indicate the center line on the stencil.

Match the stencil accurately on the marked divisions, hold it firmly against the object, then barely dip the stencil brush into the color and rub off the surplus on a piece of waste paper. Hold the brush at right angles to the stencil and move it around and around over the cut parts as though grinding a mixture, as otherwise the hairs will get underneath the stencil and blur the design. It is well to have stencil brushes of various sizes on hand. They should be very closely bound with thin ferrules reaching almost to the tip. These can be had only at a paint store.

After straight line figures and the use of one color have been mastered, no difficulty should be experienced with more elaborate designs and the use of more than one color.

For the ceiling design *J*, Fig. 2, page 78, circles drawn with a compass give the working basis. The center dots may be punched

(*Continued on page 123*)

THE HOME WORKSHOP

The Secrets of Stenciling

(*Continued from page 122*)

with a punch on a block of wood. Section the ceiling to suit the stencil.

It is readily seen that if the design is in two colors, a much prettier effect can be obtained. Two stencils may be cut, one for each color, although if the design is very simple and open, the stenciling may be done with one stencil, or that part of the stencil representing one color may temporarily be covered with a mat. In this way two or more colors may be applied with one matching. The coloring should be rather light. If, for instance, the ceiling is a light bluish tint, the four-pointed ornament might be light brown and the crest light gray, but any combination of colors may be used as long as they harmonize.

A border or frieze should be somewhat larger and bolder, or more masculine, as it is termed, than the wall pattern, but it still should harmonize with both the wall and ceiling design.

When Designing a Frieze

To draw the conventionalized frieze shown at *K*, on page 78, erect a vertical line and draw half the design, then trace it on a separate piece of tracing paper and transfer it by rubbing with thumbnail or burnisher to the other side of the line, thus completing the figure.

A wall pattern arranged in the form of a step, that is, so that the repeat takes a step each time, as it were, is an arrangement frequently used. If combined with other ornamentation, as in this case a spray, *L*, care should be taken that the design as a whole is evenly spaced. This is best accomplished by making a few trials to determine the proper location.

The general arrangement for the color scheme is as follows: the ceiling rather light, the wall pattern a shade or two darker, and the frieze a trifle darker than the wall pattern, or else the base may have a conspicuous color.

Gold or gilt decoration on furniture harmonizes with nearly all surroundings and is easily put on. Suppose it is desired to gild a neat border around a polished mahogany table, as at *M*. In this case the ledge will act as a guide and the stencil should be cut accordingly.

Furniture Stencils in Gold Leaf

Obtain a can of gold leaf size, a book of gold leaf, and a gold leaf tip, which is a wide brush for picking up the gold leaf. In order to prevent the gold from sticking all over, a tendency it has on polished surfaces, cover the part to be stenciled with pounce or pulverized chalk, using a soft cloth; then stencil the design with size, allowing it to stand as long as directed, or until it is just sticky enough to hold the gold leaf. Cut a portion of gold leaf with a knife or the point of a finger nail. Brush the tip lightly across your hair to oil it sufficiently to hold the gold leaf, and then lay the leaf carefully on the sized design. Brush off with a soft piece of cotton, being sure that no part of the design has been missed.

Another use for stencils is for centerpieces, draperies, and the like. A one-color effect, especially a medium blue, mixed with japan dryers, is often appropriate for muslin. The repeat for a centerpiece design is shown at *N*.

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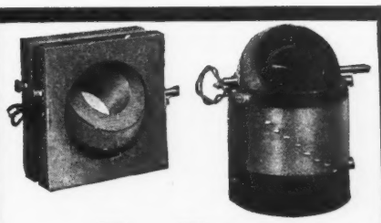

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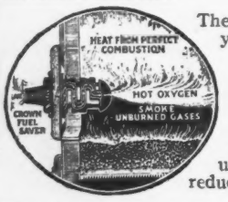

The CROWN will put you on a paying basis. It's *easy* to sell. Easy to install. Fits any furnace or boiler door. Users claim fuel-saving up to 50%, smoke reduction 50% to 75%.

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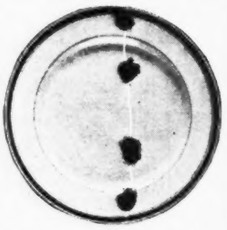
C. F. S. CO., 12 N. 10th St., Richmond, Ind.

The Shipshape Home

How To Do the Odd Jobs

Mending China

IF YOU should be unfortunate enough to break your favorite pitcher or one of great-grandmother's plates, don't fail to pick up the pieces. To cement them together you can use nothing better than ordinary white lead, according to comparative tests made by the Department of Agriculture. The white lead may be bought in a small can at the paint store or in a tube, in which form it is put up for artists' use. It may be rubbed with the finger on the raw edges of the dish and the piece which is to be cemented into place, but it is well to rub down the edges a very little with emery cloth beforehand to make room for the thin layer of white lead, so that the dish when completed will not be distorted in shape. Care should be taken not to use too much white lead.



Melted sealing wax is dropped here and there on each side of the seam to hold the piece or pieces firmly in place. The dish should then be set away and left for eighteen months or two years to give the white lead time to harden thoroughly. At the end of that time the sealing wax can be picked off and the seams carefully scraped to remove any excess of white lead. A dish so repaired will stand washing and reasonably careful handling.

Professional china menders use rivets of silver or copper wire in addition to a cementing process. If a dish is valuable or particularly prized, an expert can often supply missing pieces, restore the design, if necessary, and glaze the piece.

Patching Dishes

THE home worker can supply pieces missing from a broken china dish or vase with fair success if they are not too large. Plaster of Paris is worked up with a good quality of liquid glue or other liquid cement until the mass is as stiff as putty. Work some of the material into the space to be filled, mold into place, and rub with a wet fingertip until smooth. The material used acts as its own cement.

When the plaster of Paris is perfectly dry, it may be tinted with artist's oil paints to look like the rest of the dish, and with a little care any interrupted design may be continued or replaced. Over such painting as this, when it has thoroughly dried, it is well to apply a coat of light-colored waterproof varnish or enamel.—S. R. WINTERS.

Cleaning Painted Walls

SCRUBBING painted walls with soap or soap compounds is a long and tiresome task and often leaves the surface more or less streaked. Some spots appear unusually clean because the soap has been left on them longer than at other places.

An old painter, in giving advice as to the

(*Continued on page 125*)

LUDEN'S
MENTHOL COUGH DROPS
give quick relief

Don't Wear a Truss

MR. C. E. BROOKS

BE COMFORTABLE—Wear the Brooks Appliance, the modern scientific invention which gives rupture sufferers immediate relief. It has no obnoxious springs or pads. Automatic Air Cushions bind and draw together the broken parts. No salves or plasters. Durable. Cheap. Sent on trial to prove its worth. Never on sale in stores as every Appliance is made to order, the proper size and shape of Air Cushion depending on the nature of each case. Beware of imitations. Look for trade-mark bearing portrait and signature of C. E. Brooks which appears on every Appliance. None other genuine. Full information and booklet sent free in plain, sealed envelope.

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STROMBERG-CARLSON TELEPHONE MFG. CO.,
ROCHESTER, N. Y.

THE HOME WORKSHOP

The Shipshape Home

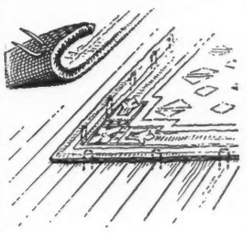
(*Continued from page 124*)

best way of cleaning the paint on walls that were coated with smoke and grime, suggested the use of gasoline applied with a heavy woolen rag. When the walls were cleaned in this way, the surface came out clean and clear; the color of the paint was revived, leaving it free of streaks and spots. Through the use of gasoline, the crevices and corners were cleaned without much effort, as it seemed to penetrate and loosen the dirt.

Try this method on any painted wall for quick results, but be careful to keep fire away and the windows open for several hours to get rid of the fumes.—A. L.

Tacking Down Rugs

ONCE the edge of a rug is turned up by children stumbling over it or other causes, it is apt to trip everybody in the household. To keep the edge in place, take a short, double-pointed tack or staple, pass one point up into but not through the rug from the bottom, turn it and bring it out at another place, so that the tack is well caught in the rug below the surface, as shown. Several more tacks are inserted in the same way along the curled edge and they are then driven into the floor. If the tacks are close together, they will hold the most stubborn edge in place.—LEROY WHITMAN, Washington, D. C.



Making Roofs Tight

A LEAKING roof can often be made watertight by the use of commercial roofing preparations. These should be brushed on with a stiff bristle three-knot brush. The coat should be 1/32 in. thick or thicker.

All open seams or loose composition shingles should first be closed with a plastic roofing cement and especial care should be taken to repair worn out, broken, or corroded flashings. When necessary, use patches of tin, galvanized iron, prepared felt or rubberized roofing, stuck on with a thicker layer of cement. This should be done before applying the finishing coat of roofing paint.—M. L. T.

Repainting Old Work

IN REPAINTING woodwork that is solidly covered and shows no signs of checking, cracking, scaling, or blistering, one coat only should be used, unless it is desired to change the color to such an extent that one coat will not be thick enough to conceal the old finish.

If the old paint is blistered, all the loose parts should be scraped, and if it is in very bad condition, it should be removed entirely.

In two-coat work over old paint, thin the first coat with 1 pt. of pure turpentine to 1 gal. of paint. In repainting with one coat, add ½ pt. of turpentine to each gallon.—J. U.

They accused him of cleaning his pipe

But he pleaded not guilty; he had merely filled it with Edgeworth

There is an old story about the youngster who washed his face and hands before going to school and none of his boy friends recognized him.

There is another about—but as this one comes in the form of a letter, we're going to give it to you that way.

1551 Portsmouth Ave.,
Portland, Oregon.

LARUS & BROTHER CO.,
Richmond, Va.

Gentlemen:

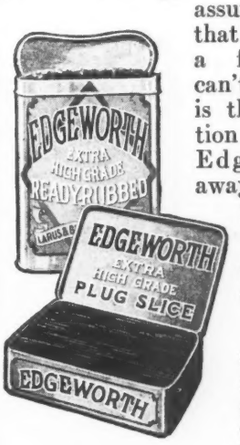
A short while ago you were kind enough to send me generous samples of both kinds of Edgeworth, and I enjoyed every grain of them.

When I lit the old pipe, several remarked on the fragrance of the tobacco and actually accused me of giving my pipe a scouring. But I had to disillusion them and tell them it was the tobacco and not the pipe.

So if I continue to woo Lady Nicotine, my best bet (and her best) will be Edgeworth.

Thanking you, I remain,
Very gratefully yours,
(Signed) Apton A. Brown.

This letter gave us a genuine surprise. Although we have often been assured by smokers that Edgeworth has a fragrance that can't be beaten, this is the first intimation that smoking Edgeworth does away with cleaning your pipe.



And of course we don't admit that it does.

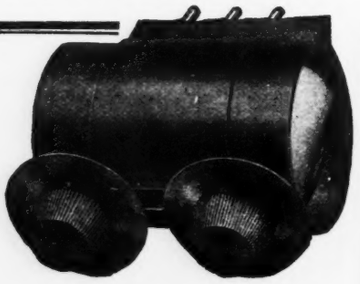
Edgeworth smokers may not find it necessary to scour their pipes often, but any pipe should be cleaned now and then—for sentiment if for nothing else.

If you haven't tried Edgeworth, write your name and address down on a postal and send it off to us. We will send you immediately generous samples both of Edgeworth Plug Slice and Ready-Rubbed.

For the free samples address Larus & Brother Company, 59 South 21st Street, Richmond, Va. If you will also add the name of the dealer to whom you will go if you should like Edgeworth, we would appreciate that courtesy on your part.

To Retail Tobacco Merchants: If your jobber cannot supply you with Edgeworth, Larus & Brother Company will gladly send you prepaid by parcel post a one- or two-dozen carton of any size of Edgeworth Plug Slice or Ready-Rubbed for the same price you would pay the jobber.

Compare TUNIT with Your Honey-Comb Coils for Short-Wave Work



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Most dealers sell Tunit. If yours cannot supply you, order from our nearest office, enclosing money order for $15.

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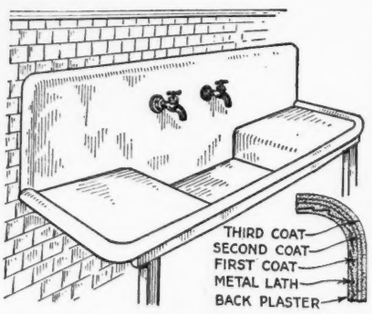
THE HOME WORKSHOP

Cement with Waterproof Coating Forms Durable Drainboard

A KITCHEN sink drainboard that costs little and will stand up under constant washing with boiling water and lye can be made of cement plaster on metal lath. The hard surface finish is given with coatings of commercial waterproofing finishes, which are easily obtained and quite inexpensive.

The foundation of the drainboard is made of wood or metal, and a sheet of metal lath is used to reinforce the cement plaster. This



To make this drainboard, cement coatings are placed over metal lath form and a hard waterproof finish is applied

is simply a mixture of 1 part of cement to 3, or a trifle less, parts of fine sand applied just as in any building operation, in 2 or 3 coats of from ¼ to ½ in. in thickness. A wooden template can be made to aid in securing the contour of the "rolled" rim.

After the plaster is in place, it is allowed to harden for several weeks. Then it is covered with a waterproof compound that acts on the free lime in the concrete and hardens the entire surface. This is followed by a cement and masonry paint, widely used for covering the exterior of masonry walls. This gives a pleasing finish and is most durable.

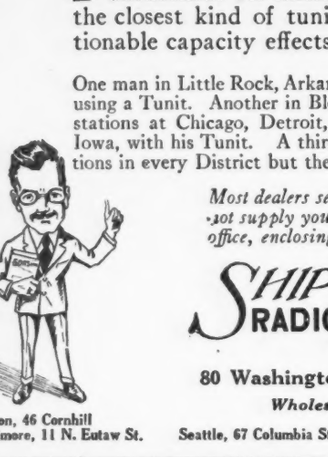
One such drainboard has been in constant use for two years and the surface does not show any sign of disintegration.—E. W.

How to Make Your Kodak Look like New

TIME and use play havoc with the appearance of the leather covering of a kodak. The writer endeavored to refinish one with a prepared "camera finish," but found that the slightest moisture caused it to crock and rub off, and a touch of water would wash it off entirely. So a simple process was worked out that has proved highly satisfactory.

The leather is first thoroughly cleaned with a damp cloth. All ragged bits are cut off with a safety razor blade, and the rough places smoothed with very fine sandpaper. Then two thin coats of the prepared finish or any good liquid shoe dressing are applied and rubbed in with a soft cotton cloth. When the finish is perfectly dry, it is gone over with a rag dipped in shellac. This must be done quickly and the shellac applied in a very thin coat, but evenly. Rub in the shellac until it begins to get tacky and catches the rag. Then stop, but give it another rubbing when dry.

The last thing is to apply from one to four coats of ordinary prepared floor wax, liquid or paste, rubbed in hard. An occasional new coating of wax will keep the camera looking like new.—G. H.



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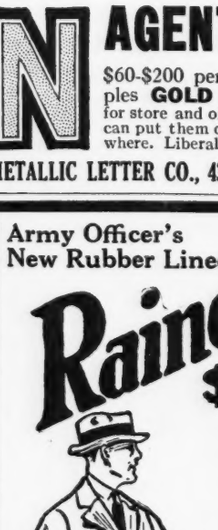

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THE HOME WORKSHOP

Soda and Salt Solution for Cleaning Silverware

TARNISHED silverware can be cleaned by dipping it in a solution of water, soda and salt in an aluminum pan. There are several methods of procedure, but the simplest is to fill an aluminum pan that is clean and free from grease with sufficient boiling water to cover the silverware. In the water dissolve the baking soda and table salt in proportions of one teaspoonful of each to one quart of water. Then immerse the silverware until the tarnish is removed.

Dipping the silverware cleanses it without in any way damaging the surface

Rinse the pieces in clear warm water and rub them dry with a soft cloth that is free from dust.

Unless very tarnished, it is necessary merely to dip the silver articles in the solution, but they must come in contact with the aluminum.

The soda combines with the aluminum and in so doing liberates a certain amount of hydrogen. This hydrogen unites with the sulphur that produces the tarnish and passes off in the form of a gas. The silver in the tarnish which remains after the sulphur passes off is redeposited, so that there is no chance whatever, according to silver experts, of this process hurting either silver plated ware or sterling silver. Salt is necessary only when the chemical action does not start readily. Zinc may be used in place of aluminum, and the same action can be obtained by placing a zinc plate in the bottom of an enamel pan.

Silverware that has oxidization or French gray decoration should not be cleaned in this way because the chemical action will clean off the oxidization or French gray with the tarnish.—E. P. Y.

Three Furniture Features for Next Month

FOR those who are interested in making and repairing furniture, the Home Workshop for March and April will contain a wealth of helpful material. An article telling how to make cedar chests of many varieties, another on the construction of a telephone table and stool, and a third on remodeling old furniture are among the big features for next month.

Articles on painting furniture, also on making "antique" furniture, are scheduled for early publication.

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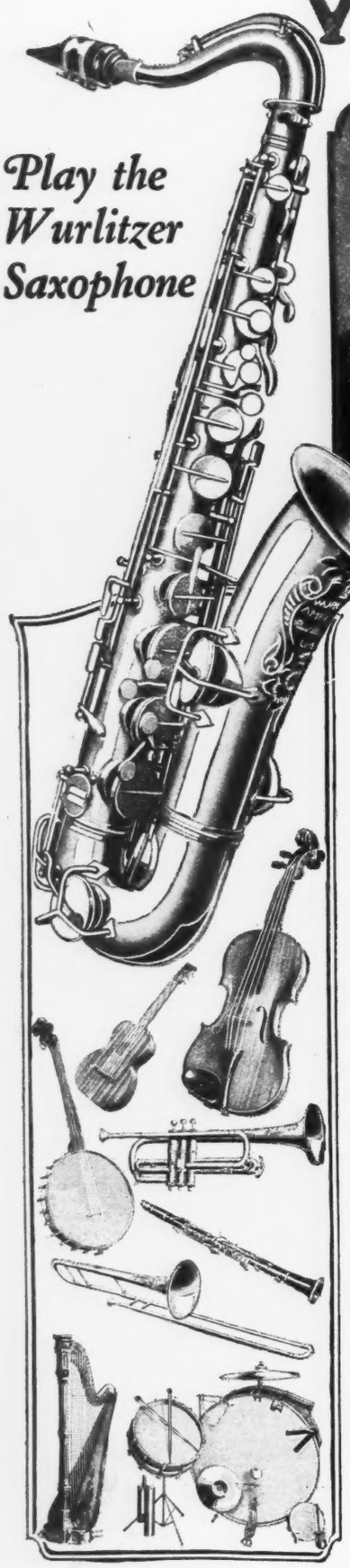

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